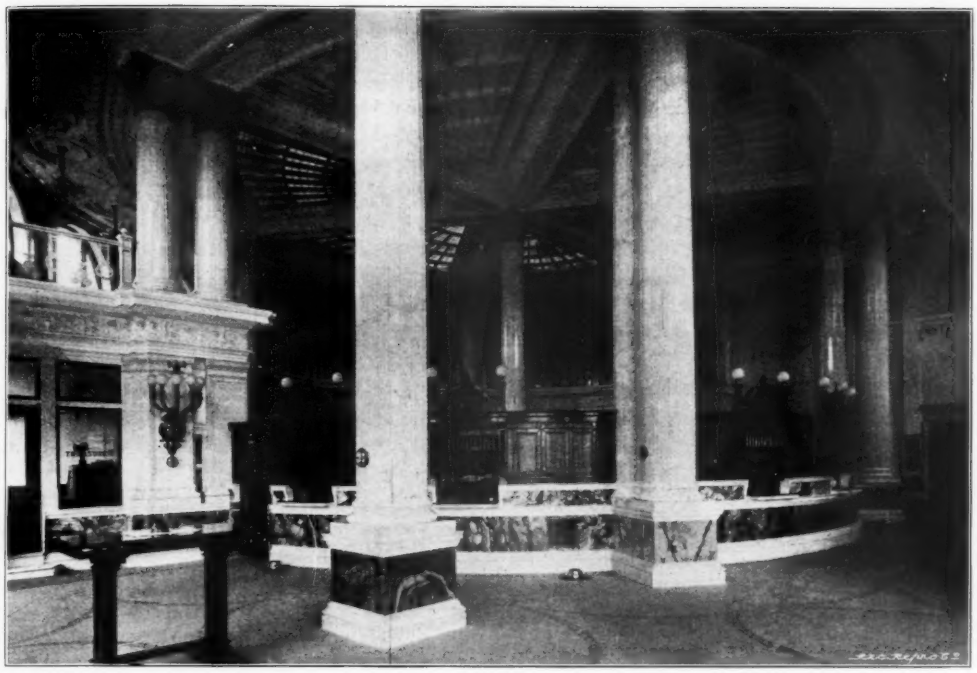


Onondaga County Savings Bank, Syracuse, N.Y. (R. W. Gibson, Architect.)

FIREPROOF CONSTRUCTION OF BUILDINGS IN THE UNITED STATES.

By R. W. Gibson (New York).

Read before the Royal Institute of British Architects, Monday, 5th December 1898.

FIREPROOF construction has been encouraged and developed in the United States more rapidly than in other countries; first, because of the vast amount of new work continually undertaken in the development of new cities, from which the evolution of improvements is natural; and, secondly, because of the growing danger and actual loss from gigantic conflagration which the dry continental climate has caused in cities constructed of combustible material. The long recognised superiority of brick walls of course induced their use to some extent even in the earliest Colonial days, and in places where at this time wooden construction prevails, because of its economical and hygienic desirability. The house or business building with brick walls and slate roof was valued, as compared with wooden buildings, chiefly for its fire-resisting qualities; but, with the growth of city buildings into crowded streets, and, upwards, many stories above them, it was soon recognised that this external casing of incombustible material gave in such a situation only a temporary respite, and that, before the heat of such fires as actually broke out, the combustible interior, with its wooden floors resting upon timber beams and divided by wooden partitions and doors, and stocked with combustible furniture and stores, made fires as hot and almost as dangerous and rapid as the original wooden buildings.

The ancient building methods of some southern peoples who preferred floors of mason-

work, which, though usually resting upon wooden beams, completely encased them in brick and plaster materials, came into use to some extent in America in Colonial times, and their superiority in fire-resisting qualities was soon noticed and afforded a practical lesson. Portions of buildings were constructed in this manner, such as halls and corridors in hotels, and their greater safety was appreciated so much as to impel further development of the idea. The increase in height and size of buildings was at the same time compelling a more liberal use of iron, and, later, of steel, in their construction, and the first efforts at fireproof building were somewhat disappointing, because of a lack of perception of the difference between incombustible materials and fireproof materials. It was soon perceived that although iron is, under ordinary conditions, incombustible, it was very far from being proof against injury from fire of even moderate proportions; while, on the other hand, the small injury done to heavy timbering in the early stages of fire led to some excess of apology for its combustibility and efforts to continue its use. There were and still are many advocates of the use of timber in very massive scantlings who show with much truth that it takes longer to impair the strength of floors and pillars of this kind than it does those of unprotected iron. Yet very large conflagrations have proved that after all it is only a question of a limit to be passed when the massiveness of the timber becomes a horrible addition to the quantity of fuel. It may be safely asserted that the days of slow-burning wooden construction are numbered, so far as concerns large cities, although possibly rural factories, where economy of construction can be partly counterbalanced by an extra organisation of fire-extinguishing machinery, and where the destruction of one building does not necessarily imperil any others, may advantageously use these methods for a long time to come.

At the same time, the exposed iron systems, even when the combustible materials were reduced almost to nothing, have failed signally, because the heat generated by the burning of fittings and furniture and stored goods is sufficient in even the mildest cases to destroy the strength of iron.

The modern system of fireproofing has been developed from these experiences upon the still older patterns afforded in the old floors with beams buried in masonwork, the modern work using steel and iron instead of wood, and perfecting and systematising fireproof protection. Its latest and present phase is the final elimination of the last of the combustible materials tolerated now in fittings and finishings, such as doors, floors, architraves, &c. The principle insisted upon is vital, and is really the first one, viz. the absolute disuse of combustible material in the construction of the building and in its fitting and furnishing. The second principle, also now well recognised, is the selection from incombustible materials of those which are also fire-resisting, and the use of these to protect others which are not and which must not be used unless they can be so protected, because the use of the building will generally lead to the introduction of some combustibles into it as materials to be stored or as materials to be used in business or daily life, and these cannot be eliminated.

The materials most available for the fulfilment of these conditions at the present day are steel or iron, and brick or terra-cotta and plaster—the metal for the reception and transmission of chief strains, and the terra-cotta and plaster for the clothing and protection of the metal.

The manner of using the steel and iron may be regarded as a question of construction, since it must now be admitted that steel and iron have little or no power of fire-resistance. The true fireproofing lies in the use of a limited number of masonry materials, for it must not be overlooked that many non-combustible materials, even in masonry, are still as unreliable as the unprotected iron-work; some granites, for example, and marbles could be and have been wrought into strong and handsome staircases, with metal strings and beams and treads of

stone, which are shattered and destroyed in the earliest blasts of a severe fire. It may be noted here that not only the intense heat, but a variation of heat, must be considered, and the destructive effect of torrents of cold water thrown upon substances raised to a white heat. Such a structure is non-combustible, but not fireproof, and it is a good example of what is meant in this distinction. Such materials may be used where their strength is not relied upon, as in wainscottings, or where they are protected: for example, if the staircase just referred to had all its iron encased in terra-cotta, and its stone steps protected by terra-cotta or plastered soffits, it could then be called a fireproof staircase.

In selecting materials for the fireproofing of others, regard must be had, not only to the destruction caused by fire, but also to injury likely to arise from the general use of the building, such as the blows and scrapes likely to be received by a column in a warehouse; and in this connection a curious but very important qualification, demanded in connection with high buildings and modern city life, is that the fireproofing must be such that, when the fire occurs, it will not be washed off by the terrific waterspouts turned upon it with modern engines. Some fireproofing, otherwise good, has failed altogether because the water from high pressure engines disintegrated it and tore it off.

Those most interested in fireproof buildings, such as underwriters and fire insurance companies, recognise fully the necessity of distinction between the several classes of fireproofing; and it is a fact that insurance rates are now adjusted according to the detailed construction of the building, instead of, as formerly, upon the broad claim that it was a fireproof building based simply upon the possession of an incombustible floor structure. The time has now come when a sufficient series of experiences has justified the holding of definite views in comparing various materials one with another. The sum of all these experiences indicates clearly the superiority of fire-resisting terra-cotta. It is one of the oldest materials used for this purpose, and has undergone many trials, and has always well performed the duty required of it, unless misapplied or imperfectly or unfairly used. The scientific valuation thus reached is confirmed by the practical tests of an open market; an overwhelming proportion, probably 95 per cent., of the fireproof floor work in use is of terra-cotta construction. It will be well, therefore, to describe in detail this generally accepted method. First, however, an explanatory description of the structural ironwork of the building is desirable. This may be divided into three classes, suited to as many types of fireproof buildings. First, the building which, being of ten stories or less, is erected by the old methods of supporting walls and superimposed columns carrying floors and roof, and with only small beams and girders or occasional independent trusses. Secondly, the building which, being of more than ten stories in height, accumulates such strains upon its walls that they must be reinforced by posts to carry the girder loads, and in which the walls require such mass in their lower parts to support their own upper parts that the metal first introduced to support the floor girders is reinforced and called upon to support the upper walls; becoming, in fact, a framing of vertical posts and horizontal girders, into which the wall is built in a series of panels of one, two, or three stories in height. This is so-called skeleton construction. When the height exceeds twelve stories, or when exposure to wind and other strains is great even at this height, the ordinary attachment of columns and girders is abandoned, and horizontal stability, no longer secured by the mass of masonry walls, is supplied by rigid riveting of all connections of posts one upon the other, and of girders to posts and beams to girders, and by the addition of bracing in ties and struts and gusset brackets; and thus is developed the final so-called cage construction, wherein the steel receives and transmits all loads to the foundations; and the walls have become mere panels, not only without vertical loads but without transverse bracing strains. Thirdly, an

intermediate type of building has arisen where all the internal structure and all the floor loads are supported upon columns, some of which are placed in the outside walls, but the outside walls themselves are made of self-supporting thicknesses in cases where architectural treatment demands sufficient mass for this purpose, and where the foundation presents no difficulty.

This classification is, of course, structural. Any one of these three classes of buildings may be finished in different degrees of fireproof perfection; which will now be considered, commencing with a study of the highest class (of the third type) of construction, since it must be allowed that the massive walls are of value in resistance to fire as well as in affording stability. In a building of this class, erected for business purposes, perhaps in the form of offices for a large corporation, with many stories to be rented to tenants, there have been achieved to-day almost perfect fireproof qualities, although few of these buildings are so rigid in their exclusion of wood as to be ideal in this direction. Yet it can be asserted that there is at no time any danger to life from fire in such buildings, nor is there any danger, with reasonable promptness, of the fire spreading from the room from which it first occurs, even though that room may be full of combustible office furniture, and may develop heat to an extreme degree. This type of building has become systematised by custom and experience, so that its structure is similar and uniform throughout the country; and this not because of building laws or other regulations, but in spite of them, since these vary greatly in different localities, and have usually been amended in fragmentary fashion to meet and treat with the new methods of design forced upon them. In New York City this is notably the case; an old building law, framed before building steel was invented, has had a few sections interpolated to regulate fireproof building; and again, at a later day, a few sections more to regulate skeleton and cage construction: the imperfection of the result is such that the new charter for the greater city recently incorporated contemplates the appointment of a commission for the complete reconstruction of the building laws. We may therefore dismiss all reference to fireproof construction in municipal laws as being of little value in the present discussion, because these laws follow, instead of leading, the practice of the best architects and engineers of the day. Some of the more recently amended laws may be quoted as codifications of opinion to their date, and as such may be of some value in presenting facts in tabulated form. Referring, then, to the national practice rather than to any laws, this type may be best described by quoting the specifications which have been used for the erection of an actual building.* It will be seen that all the fireproofing is effected with terra-cotta, the exception being some portions of ceiling work and girder covering. The floor loads are supported upon columns of rectangular shapes of rolled steel, the outer columns being set in the outer walls in grooves, close-fitting but without bond, so as to permit of unequal movements and settlements and contraction. The girders are of rolled steel, built and riveted for large sizes, and of I-beams for smaller sizes (24 inches and under), and are all riveted to the side columns, so that these may be continued right through the height of the building in practically one length. The bracing is done with gusset plates and angles. The beams supporting the floors are small rolled steel I-beams, laid out to what has become a standard distance apart—viz. 4½ feet—and of what has become a standard of economy in size—viz. 8 or 9 inches.

This size and spacing arise from the use of the terra-cotta arch, of from 8 inches to 10 inches in thickness, which is, theoretically, good for ordinary office building loads up to a span of 5½ or 6 feet, and practically and thoroughly good and reliable up to spans of 5 feet,

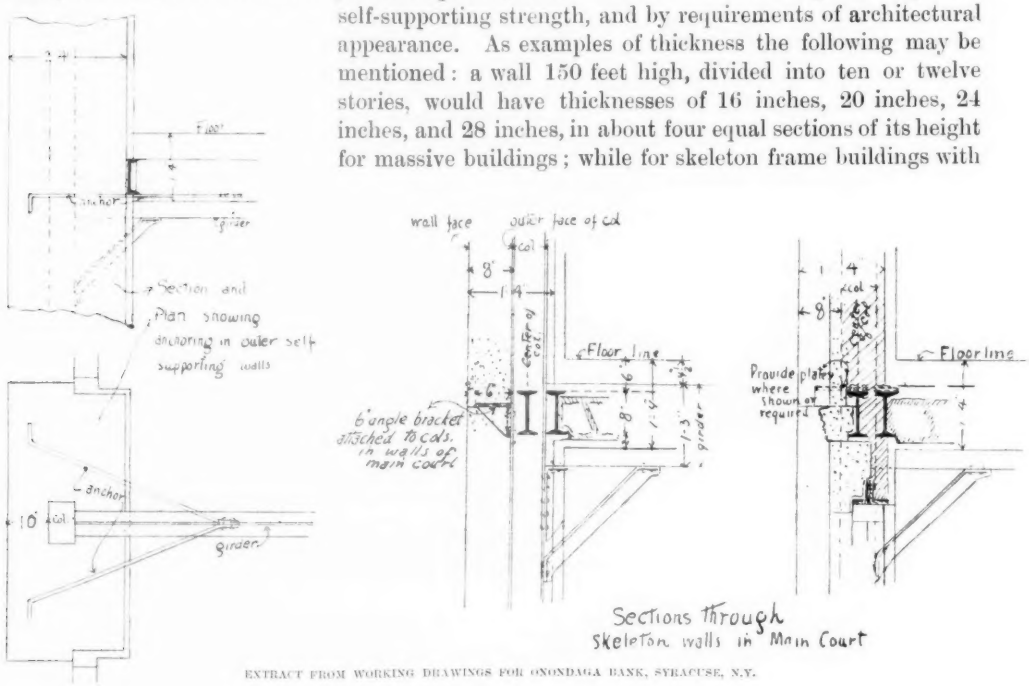
* The original specifications of the Onondaga County Savings Bank, Syracuse, N.Y., designed by the author of the Paper, were exhibited in the Meeting-room.

with sufficient factor of safety to permit of such cutting as may afterwards be necessary for the insertion of pipes, wires, &c. Many experimental tests have been made with these floor arches, with greatly varying results. They have been built with spans 7 or 8 feet, and have endured tests at these spans for very great loads; but the difficulty of securing in a building the perfect workmanship used in a test makes all such records of small value as compared with custom arising from an accumulation of experience, and such custom has decided that $4\frac{1}{2}$ to 5 feet is the span of flat floor arch combining the necessary strength with desirable economy of construction under working conditions. As thus used, these arches are very economical, very adaptable, and elastic in their application, and requiring only a moderate degree of skill on the part of the workmen. They are made of hollow terra-cotta blocks, with joints inclined at a fixed angle, which is only a rough approximation to the theoretical radiation of such joints in a flat arch; but there is no practical difference in the strength, and there is a great gain in having three patterns in all the blocks—viz. the springer, which rests on the flanges of the floor beam, the intermediate blocks, which are all cut to the same inclination, and the key-block, which, of course, has the sloped joint on both sides. The springer is made so that the lower surface forming the soffit or ceiling stands about $1\frac{1}{2}$ inch below the lower flange of the iron, and covers one-half of that soffit. The work is set upon a centering consisting of simple scaffold-boards hung $1\frac{1}{2}$ inch below the soffits of the iron beams; upon this centering the arch blocks are laid, and there jointed and flushed in cement. As soon as the work is set the centering is removed to a new panel, so the work goes on continually. It is customary to set the arches forming the floors as soon as the iron is ready for them, without regard to the condition of the walls or the absence of any roofing. In a building being hastened the iron-work will usually be seven or eight stories high before the walls are commenced, and the floors will be within two or three stories of the top at any time. Upon these arches a layer of cinder concrete is deposited, and upon this the finished floor, consisting of paving or tiling, or a composition of a concrete nature, or sleepers and wooden floor. A variety of floor arches of late date is the "end construction" arch, in which the perforations of the terra-cotta are arranged in the direction of the stress in the arch instead of at right angles to it, so that a larger quantity of material is used under strain; but it is doubtful whether this is of much real advantage—it is rather the product of severe testing than of any practical need.

As the floor arch determined the distance apart of the floor beams, so it next regulated the distance apart of the girders. The span of the arch is indicated by its own working strength, and the depth of the beam is indicated by the thickness of the arch, because any considerable difference would have to be made up by concrete filling upon the top of the arch, which would be more expensive than the arch material itself. Then the depth of the beam having been determined within reasonable limits, its economical span is easily ascertained. This proves to be somewhere between 14 and 18 feet, which is the working distance between the main girders, and which, being a convenient size for a single office, is also taken as the unit of room width and the space allotted in the outer walls to a pair of windows. The distances will of course vary according to the floor loads adapted for different purposes; those mentioned apply to buildings having floors weighing from 75 lbs. to 95 lbs. dead load per foot, and supporting live loads from 75 lbs. to 150 lbs., which are the usual limits for offices.

As soon as the rough steel frame is completed and the floor arches are all in, the outer walls are usually half way up, and the roof can be given its final covering. It is constructed with arches, the same as the floors, except that sometimes the steel beams are laid to the necessary pitch of about half an inch to the foot, so as to avoid the weight and expense of filling, which would be necessitated by level beams and arches. Sometimes an intermediate floor is

temporarily converted into a roof so that the stories below it can be enclosed and warmed and finished. The walls need not be described in detail here, as they present no novelty in a building of the class under discussion. In general practice their thickness is made about two-thirds of the full thickness required for walls supporting the floor loads, and they are secured to the metal framework so as to receive its assistance in resisting horizontal wind pressure; but, as before mentioned, they are built around the columns in such way as to permit of their unequal settlement. The walls containing many windows are not usually considered as walls, but rather as a series of piers and panels, whose thicknesses will be regulated by their self-supporting strength, and by requirements of architectural appearance. As examples of thickness the following may be mentioned: a wall 150 feet high, divided into ten or twelve stories, would have thicknesses of 16 inches, 20 inches, 24 inches, and 28 inches, in about four equal sections of its height for massive buildings; while for skeleton frame buildings with



EXTRACT FROM WORKING DRAWINGS FOR ONONDAGA BANK, SYRACUSE, N.Y.

walls supporting only their own weight the thicknesses might be 12 inches, 16 inches, and 20 inches, in three divisions; and for cage construction, with every story of walls supported separately on the frame, 12 inches throughout would be good practice. The New York law stipulates, for skeleton or cage construction, that the walls shall not be less than 12 inches for the uppermost 50 feet, 16 inches for the next 50 feet of height, and so on downward, adding 4 inches to each successive 50 feet, this being required in a law influenced strongly by the fire department for the sake of the stability of the masonwork itself. It is doubtful, however, whether it is worth while to urge greater thickness of wall below than above in a structure of pure cage skeleton type, unless exposed on one side to heavy fire risk from a combustible building, against which a well-built hollow wall with considerable mass of material is no doubt the best safeguard; yet, even here, 16 inches of brickwork, in two thicknesses of 8 inches each, would be relied upon to withstand any fire with the assistance likely to be rendered. The thickness of material necessary to resist the weather is found to be 12 inches at least of brickwork with terra-cotta interior furring.

Furrings are used in all American buildings, even of the cheapest class, to afford a dry and warm base for the finishing plaster-work; in cheap buildings they are light strips of pine, 2×1, nailed to the brick wall which receives the lathing, just as the quarters or studs of a partition. In fireproof buildings the furrings are hollow terra-cotta slabs or tiles 2 inches thick, and 16 inches by 8 inches, or other convenient sizes, built up against the inside face of the wall and secured with iron where necessary; sometimes, to save space, furring blocks of hollow terra-cotta are made the customary size of bricks, and the innermost four inches of the wall is built of these bonded with the brickwork, and this is permitted in the New York building law; but the protection against driving rain and condensation internally in damp weather is not so good. The efficiency of the wall as a clothing to the metal has been variously estimated, some authorities requiring that at least eight inches of brickwork or similar material should cover all iron to protect it from moisture and fire. The New York law permits a minimum of four inches, and there is no proof that it is insufficient, if reasonable care is exercised to prevent a concentration of moisture or heat at such a spot. It should be observed, however, that in the United States it is customary for every building to possess its own side walls independently of its neighbour, so that where important buildings actually join there are usually two walls to resist the transmission of fire; party walls are rare.

Assuming, therefore, that all the steel-work has been externally covered with masonry, affording from four to eight inches protection, the interior of the steel frame is protected in another fashion; this is, briefly, the extension over all of its exposed surfaces of the two inches of terra-cotta furring before mentioned. In some places a greater thickness than two inches is used, and urged, and where risk of great heat occurs it is undoubtedly wise; but a minimum of two inches of hollow tile with one inch of plaster has been demonstrated to be thoroughly effective, if well secured, in any fire likely to occur in residence or office building structures; three inches for ordinary, and four inches for dangerous storage may be considered good. First, all the iron posts and columns are covered, those next the walls usually to form square pilasters by the use of rectangular two-inch slabs, and the columns standing clear by means of segmental blocks with flat backs and with circular fronts fitted to the columns so as to give a circular finish over the square steel-work. It may be noted here that most of the steel column work is formed of sections which give an approximately square column, and occasionally the column finish of terra-cotta is also square, but not often. The preference shown for square column sections is undoubtedly based on the facilities for splicing superimposed lengths, and for attaching the angles and brackets required to support the girders and beams, and on the possibility of bringing the girder load upon the column near to its axis so as to avoid undue eccentricity of load. For moderate loads the Z-bar column is a great favourite for these reasons. Supporting eight or ten stories, however, the box riveted with plates and angles offers equal or greater advantages, while for the lightest loads a latticed channel column is most economical and adaptable; all of these are square columns. The round columns, such as the Phœnix segmental and certain octagonal and polygonal columns, while theoretically perfect as columns are difficult to assemble, and afford only imperfect facilities for attaching girder brackets, struts, &c.

The girders are protected by slabs of terra-cotta, as before described, secured with hooks and bars and wiring, and are usually given their outer form by means of metal lath upon light iron bracketing to receive the finished plastering, thus permitting uniformity of appearance in the ceiling design, while the girders within are of sizes varying according to their span and load. The soffits of the common joists or floor beams are protected, as has been before remarked, by the lower surface of the floor arches extending beneath them. All the

steel-work thus covered is plastered: the rough coat being utilised to correct the form, and the final coats being frequently one of the exceedingly hard patent plasters which have become popular of late years. The lower portions of walls and columns are frequently finished with marble slabs, one inch thick, or with tiling, which is certainly an additional protection against the disintegrating effect of the water, even when not of much value against fire. In work where economy is urgent, and a lower standard may be tolerated, all the iron is protected by a covering of metal lathing, and a heavy coat of cement scratched and finished with ordinary plastering: but this is liable, as has been seen, to be damaged by water, and is insufficient in its actual mass.

There is a good deal of difference of opinion with regard to air spaces within the fireproofing, and great value is clearly proved for air spaces such as those afforded by hollow terra-cotta, which may be described as numerous and discontinuous, that is, affording no regular and extended communications; but it is clear that large and connected air spaces may, and probably will, act as flues when broken into, and actually draw flame and heat into places where it is most harmful. For this reason those methods are preferable which place the fireproofing material close to the metal and preserve numerous and frequently broken air spaces in their own substances, rather than those which, standing away some distance from the metal, leave it liable to attack inside of the protection. Bearing this in mind, a greatly improved cheap column protection can be made by using one coat of metal lath and cement in contact with the column, and a second coat furred out from the first upon metal lath upon light iron bars so as to preserve an air space between the two thicknesses of cement. This protection is finished with hard plaster which would stand the action of the fire-hose, and should be almost as good as the terra-cotta and considerably cheaper. These two systems may be fairly claimed to represent the best practice in covering iron, and in the event of unusual fire-resisting power being required it is evident that it can be obtained simply by adding to the thickness of the terra-cotta covering or to the number of coverings.

The greatest need of improvements in fireproof work is the bringing up of the lower grades to the level of the higher by a system of insurance inspection, or something of the kind, which will present in tangible form, to a certain class of owners, the value of good work which they do not themselves understand. There is a tendency in all building, and at all times, to put inferior work in places where it is soon covered up, and in fire resistance we have been working on so small a margin that there is little chance of doing this without injury.

After the structural steel is all protected the partitions are built; these are of various patterns, the best being undoubtedly the terra-cotta blocks, four inches thick for average heights, three inches for moderate heights, and six inches for great heights of story. They are occasionally stiffened with angle iron framing, when so cut or thinned as to be weak, but they show an extraordinary strength when well set, as they usually are, in Portland cement. Minor partitions, subdividing large rooms and sometimes all the partitions except those next corridors, are frequently built by using light angle iron posts or quarters covered with metal lath, and plastered either like the old-fashioned wood plastered partitions, or sometimes with very thin posts and one sheet of metal lathing only, so as to make a solid plastered partition about two and a half inches thick, which seems to work very well, although a three-inch tile partition will dry quicker and cost only a little more. Either of them will resist the passage of fire from one room to the next under ordinary circumstances.

When a building reaches the stage here described, that is to say, when it is ready for the joiner's work, it is probably more fireproof than at any other time. It has practically nothing combustible in its construction. The tendency to-day is to reduce more and more the amount of woodwork admitted after this stage in finishing, and to substitute fire-

resisting materials, in places where it has hitherto been thought impossible; not only doors and sashes, but even glazing and office furniture can now be obtained of fire-resisting character, and their use is of very great value. A building of first-class fireproof construction, such as is found in New York, ten years old, to-day, can, and occasionally does, become the scene of a very violent conflagration. Several such have occurred, and although with the aid of the fire department they have been subdued before spreading beyond the rooms where they started, yet the amount and character of the damage done sufficed to point out the need of much greater strictness in selecting building materials. Consider the quantity of fuel present in an active lawyer's office in two or three rooms; there will be six or eight desks, two or three hundred feet of book and document shelving, beside chairs and tables and other customary furniture. As usually built, the roll-top desk is a perfect fire-trap laid for ignition, and often the waste-paper basket is placed beneath it and filled with paper ready for the match which is dropped in by some careless smoker. Several fires have originated in just this way. When once started it is soon discovered that the amount of fuel present makes a fire which exceeds the control of the tenants and janitors. Possibly there is a wooden panel partition dividing one of these offices from the next; in any case there are almost surely wooden doors with wooden architraves and jambs, and with glass panels, and, if the building is not of very recent date, possibly some wooden wainscotting and window panelling. The wooden floor may be pardoned, because it is rarely that fire reaches it; the natural draught upward in the supply of cool air from the bottom seems to protect the floor for a long time, and then when the water is poured into the room the floor is naturally again most protected. But all the other woodwork above mentioned should be banished in a building claiming to be fireproof.

The doors and architraves should be of sheet metal, wood cores must still be tolerated; such are already upon the market, and have been used long enough to demonstrate their practicability. The window architraves and jambs should be of hard plaster, and the window frames and sashes of chemically treated fireproof wood or of metal. The borrowed lights in the internal partitions generally used to light the interior corridors should have similar sash and trim, and these and the doors should have wired glass, which is also a demonstrated success in its ability to hold together and check draughts of hot air and flame, before which ordinary glass disappears. The outside glass windows must probably be tolerated in large panes of plate and sheet glass, because the value of the light and view doubtless exceeds the price paid for it in extra risk. As to the furniture, a really first-class office pretending to be fireproof, such as that of a large bank or public department, can and should have metallic book shelving, and desks, and cabinets, letter files, &c., all non-combustible, even though they scarcely claim to be fireproof in the same way that a safe is so made. It is of great importance that such things do not add to the fuel in the critical moment when the fire is commencing. The desks and tables may have wooden tops upon metallic frames and pedestals—in other words, the wood may be reduced to such a minimum quantity that the risk is almost nothing. Of course there remain the papers, books, implements, &c.; but this risk can be taken care of by the fire-hose of the building.

Every first-class building should have, and in New York does have, a number of private fire-hoses so distributed that every part of the building can be reached by one of them. They are of small diameter—about two inches—and are supplied by a large tank on the roof, and frequently by an auxiliary pump in the machinery department in the basement, in case continued use is required. As it has sometimes happened that the water has failed by reason of the main being found shut off when wanted, it is undoubtedly best that the fire main should also be the chief distributing main of the building; its extra size will be no harm, but the water

will be always there ready for use. Such an apparatus has nipped in the bud many an incipient fire, and with this, and the care above mentioned as to materials, a building may really claim to be fireproof. A few buildings come almost up to this standard of protection. The use of the fireproof doors and architraves and wired glass is yet rare, but in all other respects a high standard has been reached. One may walk into a new banking room and find it difficult to discern any combustible material in sight, except the desk tops and the window sashes; even the floors are very frequently of mosaic or some ornamental cement composition or marble, although, as before remarked, the wood floor is the smallest risk. Even in ordinary fireproof buildings, where offices or apartments are rented, the halls, stairs, and corridors, and elevator shafts are entirely incombustible. Something remains to be desired in the protection of the staircases from flame at their soffits, because they are usually built of iron strings or carriages with marble treads all visible beneath, and, as will be shown later, fire may be carried to them from very distant points; still, the complete banishment of wood from these departments is of value. But it is true that the ordinary so-called fireproof building still retains too much wood; what is most needed is the bringing up of this class to the higher standard; the expense is not very great, and would no doubt be covered by saving in insurance and risk.

It is interesting to note from actual observation, first, how a fire starts in such a building, and, secondly, how it spreads. There seem to be three principal sources of fire: one is the engine-room and rubbish heap (if such be permitted) in the cellar, including, perhaps, that part of the electric wiring which is somewhat chaotic at the foot of the shaft. Next, the waste-paper basket, with the cigar-ash or match thrown in; and, next, ignition from an adjoining or opposite building already on fire. The fire originating in the basement is perhaps the greatest danger, but it is usually soon detected, as men are on duty here at all times. It is frequently found fostered by an oil store, where lamps and oil-cans are abundant. Such a thing should never be permitted at the foot of a stair or elevator shaft, nor should any large quantity of such combustible be admitted. The basement end of all elevator shafts and staircases should be completely closed off by tight iron doors, not latticed, but as nearly as possible air-tight doors and screens, which will serve to prevent fire draughts, and also to cut off engine-room smells from the upper parts of the building. This is done in the best buildings, and should be done in all. Its need is recognised in the building law of New York, which compels such treatment in apartment houses, and further orders that the floor over the cellar shall be fireproof even in apartment buildings of non-fireproof character in other stories.

The waste-paper basket and desk origin of fires is wonderfully rapid. Such a fire will make an office absolutely untenable within ten minutes from its commencement. Inasmuch as incombustible furniture can hardly be brought into general use at once, the most practicable present defence against such a fire is the fire-hose in the building, always at the disposal of tenants or any person willing to use it. With such fireproof construction as has been before described as perfect, such a fire can be safely left to burn out its own room if the door is closed and help is not forthcoming; this, in fact, has occurred in some cases in New York.

The next mentioned source of danger—fire from an opposite building—is very difficult to meet. When an intensely hot fire occurs in a narrow street, the glass windows opposite will begin to crack, and the window-frames and sashes to smoke; constant attention by firemen may for a time prevent and extinguish the little fires thus started, but they frequently break out at a dozen places at once, where window-frames and sashes and inside jamb panelling afford the most advantageous conditions of combustible material and fanning draughts of air, and then the fire is within the second building. This process is true of fireproof buildings

as well as non-fireproof, for not more than half a dozen in New York City have incombustible sash frames and sashes. Something is done by setting the sash frame so far in the offset of masonwork that the latter completely covers it, leaving only exposed the outer bead, and even then the sash is dangerous and demands improvement. From adjacent buildings heat communicated through the walls attacks wainscottings, base boards, skirtings, and the like, and none of them are tolerated in the best fireproof work unless made of stone or metal. The skirtings are frequently of marble or slate; wainscottings and dadoes of tile or marble.

The manner in which fire spreads in a building has been very imperfectly described, probably very little understood, except by firemen, until these recent efforts to withstand it. It is easy to see how flame is communicated from one combustible mass to another, how it burns along a handrail or up a wooden elevator guide, or through a door admitting flame from one room to the next; but the passage of fire from one portion of a building to a remote part, apparently skipping intervening places, has been considered mysterious and unexplainable, yet is really very simple. A hot fire in a single room will generate a great amount of combustible smoke which consists largely of gas: this rises by reason of its heat, and escaping through fanlights and transoms, or open doors or windows into adjoining corridors, will travel, because of the wind draught, through the building a very considerable distance without being much diluted, and occasionally it will preserve such proportions of gas and air that a leaping flame in the original fire will ignite all the smoke practically at once in a kind of a low-power explosion. This may be on a very large scale in a very large building; a whole floor of a warehouse, for example, will become a mass of flame in an instant from a little fire in one corner, or it may be only a small volume of gas that is ignited in a long corridor of an office building; but, in either case, the fire, originally upon one side, may, after such an explosion, appear in many other places remote from the first. This is one of the risks which, in fireproof building, should be guarded against by the use of fireproof doors and wired glass, and it is to meet this danger that it is becoming recognised that corridors and landings and stairs should not be of single unprotected construction, but should have some guard against flame, even though it be admitted that the full fireproof flooring is not necessary.

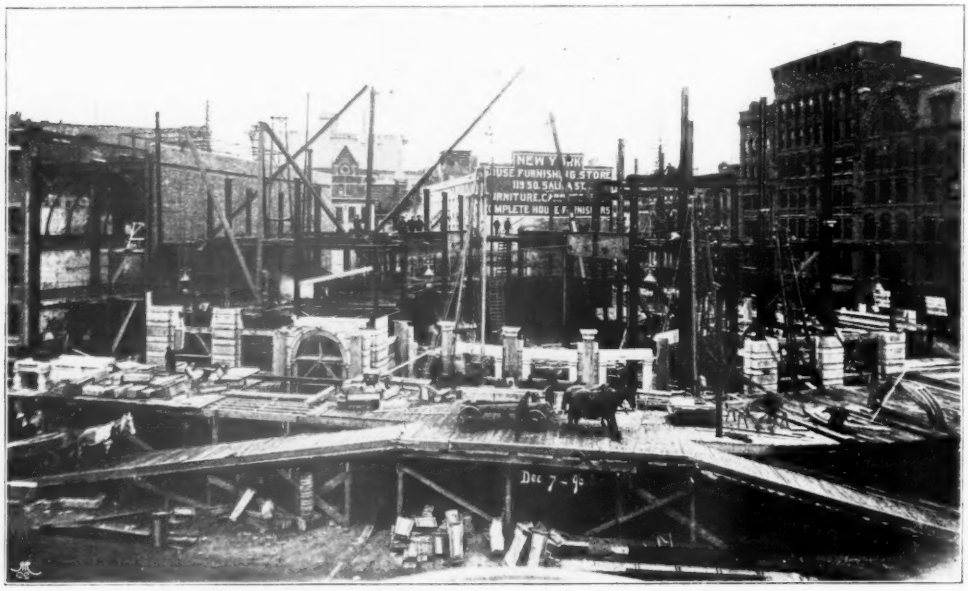
An important effect of heat upon unprotected metal and, to a smaller extent, upon that which is protected, is the expansion, which may amount to a destructive quantity. Usually the protection herein recommended is sufficient to limit expansion to the extent necessary for riveted construction; but where ironwork, whether weight-carrying girders and trusses or merely external facings, is built upon and within masonwork walls and piers, and is unprotected from heat, it has sometimes pushed the masonwork out of plumb and thrown down portions before it actually failed of itself. It would, no doubt, be a good rule that all iron framing upon the fronts of buildings, such as bay windows and large mullions, should be protected with terra-cotta to the same extent customary in the interior.

A second chapter of this essay might well be devoted to dimensions and specifications of customary fireproof building; but it is thought best to supply these in an actual example. For this purpose a set of working drawings and specifications and strain and load diagrams of a first-class bank and office building designed by the writer, and recently erected in Syracuse, New York, have been selected as affording a good example of what is actually done.* Some interesting photographs show the building in course of erection in various stages [pp. 60–61]. The specifications supply full and close details of almost every question of construction. Although the building is not erected in New York City, it was strictly of metropolitan style and methods, and was erected by Chicago contractors. For convenient

* The drawings, specifications, and diagrams referred to were exhibited in the Meeting-room.

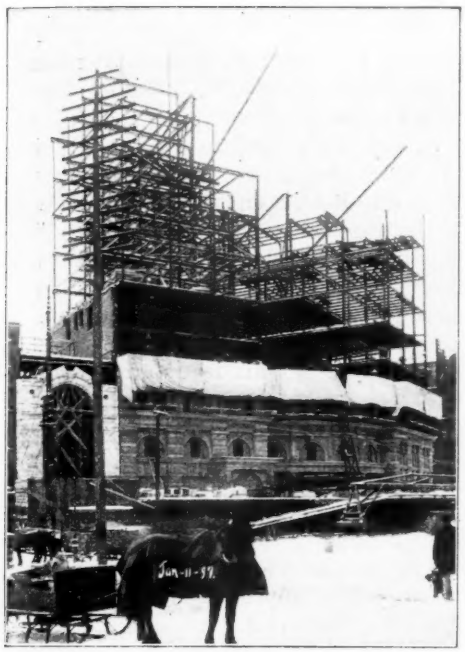
reference upon any other points of construction not included in this example may be mentioned a handbook by J. K. Freitag, entitled *Architectural Engineering*, published in New York, by John Wiley & Son, and, London, Chapman & Hall, Limited, 1895. Naturally some developments have occurred in the few years since this book was written, in fact, progress is, in this department of science, very rapid; but nothing of primary importance has occurred.

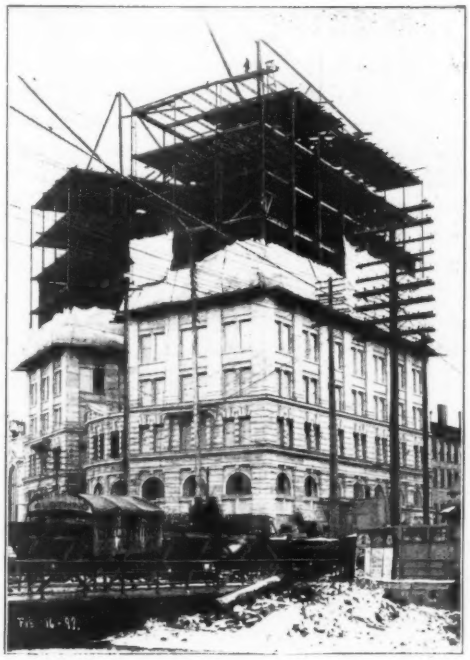
In foundation work it is considered better in more recent practice to use heavy section rolled beams instead of railroad iron, and it is undoubtedly better to reduce the number of tiers of superimposed beams, and, if possible, construct each raft with one layer of beams and one collecting girder which really replaces the upper tier of beams. This girder is made as deep as space permits, and partakes of the nature of an iron base stool,

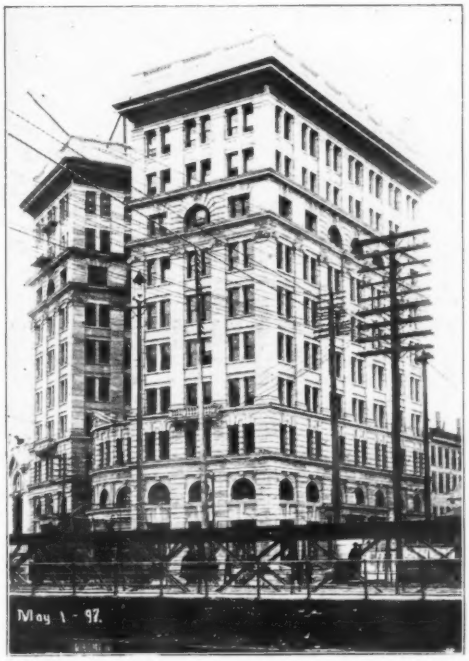


ONONDAGA COUNTY SAVINGS BANK, SYRACUSE, N.Y.

with offsets much elongated in one direction. Mr. Freitag's book mentions certain forms of brick and concrete floors which are still used, and for which advantages are claimed. Other floors are constructed with light steel angle bars between the main floor beams carrying a light concrete covering, and finished underneath with a metal lath ceiling plastered in the usual way. Yet another floor uses metal ribs in segmental form between the main beams to secure the virtues of the arch, much like the old corrugated iron fireproof floors. Some patents have been secured, and are being worked, claiming advantages in certain mixtures of concrete, as, for example, one which uses wood sawdust; but the practical public verdict with regard to all the systems of fireproofing may be summarised in the statement that in an enormously large proportion, probably over 90 per cent., of all the work done some form of fireproof terra-cotta is employed, and nearly every architect, engineer, or builder, who is unprejudiced by interest in one form or another, will admit that on the whole the terra-cotta is the most reliable and the most satisfactory.







ONONDAGA COUNTY SAVINGS BANK, SYRACUSE, N.Y.

(R. W. Gibson, Architect.)

Throughout the above descriptions no mention has been made of porous terra-cotta. It should be explained that this form of material is preferred by many experts, as having better resistance to damage under either fire or water than the hard ringing terra-cotta. It is made by mixing the clay with sawdust, which, in the burning is, of course, destroyed, leaving the earthen material in cellular form. Many of its advantages are apparent without explanation; it will hold nailings, and is therefore used for roofing slabs, and blocks to support metal coverings which require holding by such methods. It is also used in brick and hard terra-cotta work for nailing blocks, just as wood blocks and plates were used in older brickwork. Porous terra-cotta nailing blocks enable the builder to entirely dispense with wooden blocks and nailings and bracketings, an improvement which is of vital importance. There seems to be no good argument against the use of porous terra-cotta throughout the flooring, partition, and furring work, except that in some localities it is rather more expensive, and although it may show slight superiority, yet the hard terra-cotta is so satisfactory that, where it is the cheaper form, it is quite justifiable to use it. In New York City most of the work is done with hard terra-cotta, using the porous for nailings.

The New York City building law is so imperfect that its revision is now in hand; but its stipulations as to thicknesses of walls, and strains in various structures and materials, may be taken as typical of American practice of conservative tendency. Many cities have laws less exacting, and doubtless the new law for New York will tend in that direction. New York law stipulates 100 lbs. per superficial foot floor load for office buildings; a few years ago it demanded 150 lbs. Most of the expert opinion to-day would agree that 75 lbs. is sufficient, with the provision that any single foot of the floor should be capable of supporting a larger load, say 500 lbs., the 75 lbs. referring to distributed load over the whole surface; the reason for this distinction is that an office floor is never likely to be loaded throughout with more than 75 lbs. per foot, and beams and girders of this capacity are undoubtedly sufficiently strong, yet a concentrated load, such as a burglar-proof safe, may be placed occasionally upon a limited surface, and the structure should therefore be of such a nature that this point of strain may be equal to the emergency, assuming that the surrounding surface is not loaded. In other words, the weakest point of a beam or arch (viz. its centre) should be capable of a centre load of considerable magnitude, as well as being proportioned to the distributing load first stipulated. Difference of opinion and practice exists in regard to column loads. The New York law requires that the whole of the theoretical load, amounting in office buildings to about 180 lbs. (80 lbs. dead, and 100 lbs. live), should be accumulated floor by floor upon the columns, that is to say, the lowermost column should be capable of supporting every floor above it fully loaded. The Chicago architects, however, have calculated, and their views are gaining ground, that the assumed live load of superimposed stories may be decreased in calculating the strength of columns as the number of stories increases. The assumption is that the greater number of floors, or the quantity of floor space in question, the less likelihood of the maximum load in office buildings and dwellings being reached throughout simultaneously. The Chicago law has recognised this principle, although no particular rule as to its application seems to prevail. In some cases the uppermost story is calculated with the full live load upon the beams (of course the full dead load is included on all members), and about 86 per cent. of the live load upon the girders and columns, then the next story with the same loads upon the floors and girders, but only 80 per cent. of the additional load upon the columns; the next story with only 75 per cent. of the load upon the columns, and so on down; so that in the case of a building of 15 or 16 stories, the lower columns in the first, second, and third stories are calculated for live loads on those stories of only three or four pounds, or in some cases nothing at all; and the foundation is accurately adjusted

for the dead loads with no provision whatever for live loads, it having been found that a foundation, sufficient when new, acquires considerably greater strength to support temporary loading after having properly settled and taken its bearings. This may be a somewhat daring theory, but it provides a column in the lower storey which is sufficient for the full average load for the building, say, about 25 lbs. per square foot of floor surface, and the material is placed in the most scientific as well as the most practical manner; but it is argued by many authorities, especially in New York, that municipal regulation of buildings is unable to completely control their uses after they are finished, and that although a building may be erected for offices or apartments, parts of it are likely to be converted to the use of light storage or light manufacture or to other purposes, and a considerable margin should be provided to cover such contingencies. Some buildings have been designed with the live load calculated at 70 lbs. per foot on the beams, 50 lbs. per foot on the girders, 40 lbs. per foot on the columns, and nothing upon the footings; the dead load being, of course, included to its full amount, about 90 lbs. throughout.

The building by the writer, before referred to, was designed and calculated as follows:—

Load on all beams	= total dead load	+	70 lbs. per ft. live load.
Load on all girders	= total dead load	+	60 lbs. per ft. live load.
Load on columns of three upper stories	= total dead load	+	60 lbs. per ft. live load.
Load on columns of remaining stories .	= total dead load	+	40 lbs. per ft. live load.
Load on foundations	= total dead load	+	20 lbs. per ft. live load.

There is no doubt that the New York building law will permit of a decreasing percentage of the floor load upon the columns of many-storied buildings—and possibly a decreasing but never vanishing proportion will be the basis of the rule: as, for example, a reduction by 5 per cent. at each story of the total live load brought down from superimposed stories, the percentage being reckoned in each case upon the total, and not upon the original, floor loads; and of course, as before stated, the full dead load being included on every member throughout.

Another reason for abundant provision of strength in fireproof office building is the custom of building fireproof partitions, counters, and heavy desks upon the floors without special regard to their positions over beams or girder. A floor is rented by a bank, for example, and is loaded with a marble counter and steel fittings weighing possibly over 300 lbs. per lineal foot, or perhaps a partition with a very narrow base. These things cannot be prevented, and therefore should be provided for; their place cannot be anticipated, so the only provision is a general stiffness of the floor, which, however, need not be carried to the columns, except as already averaged.

As to the load on foundations, practice varies very much. The enormous pier loads showing considerable inequalities require an exact adjustment of their superficial area to the load to be supported, or else the building will be racked and cracked by unequal settlements. In Chicago settlements of four inches are not at all extraordinary; in New York one inch is quite frequent. If two piers are made with equal size base courses, and one is loaded with 500 tons and the other with 250 tons, the more heavily loaded pier will settle more proportionately than the lighter loaded one, and the building will be out of level, and will show cracks. This has actually occurred by reason of municipal regulations as well as because of too theoretical a view in calculations. Long since the days when it was recognised that the foundation must be proportioned to the load, buildings have been erected where one pier supported 520 tons of dead load, and another pier 500 theoretical tons, of which 200 were dead load and 300 live load, an arrangement which taught the lesson that a live load

which was continuously absent would have no effect upon the building, and provision for it would be injurious. As a fact, such columns and piers have been found standing from one to three inches higher than their calculated settlement. From this position arose a custom of disregarding the dead load, by the experience, before mentioned, that a foundation, after it reached a certain age, would bear temporarily and within limits increased loads without any further settlement. Many Chicago buildings are so calculated with their dead loads equally balanced and with no provision at all for live loads, and in most cases it has worked well; but there is always the risk of a greater load being imposed, which would cause serious damage; in fact, it happened on one occasion that a warehouse had to be emptied most expeditiously, because the column foundations were sinking into the Chicago mud with dangerous speed.

The better practice undoubtedly is, to proportion the foundations to the true average load which they will have to bear, and which will be found to amount to 15 or 20 lbs. per superficial foot in offices and dwellings—sometimes something must be added to cover heavy decorations and finishings, such as marble wainscottings; but generally 20 lbs. will provide for this, and when added to the dead loads will not make the column foundations too large for their work. The character of the soil will, in some cases, permit without injury considerable variation in the load per foot upon the base course, but on all soft or compressible soils the problem is a very serious one when from ten to twenty fireproof floors are built upon them. Superfluous strength in the columns is not injurious, it is simply uneconomical; but superfluous strength in the foundation base course is positively a danger to the building. The only safe practice, therefore, is that which arrives most correctly at the actual load to be supported, and proportions the work accordingly.

Much of the above comment relates to construction, as such, distinct from the fireproofing; but the two are so intimately associated that they have been evolved one with and for the other. It is easy to see how the same principles of fireproofing could be applied to construction of a different nature, and it is evident that the experience gained in regard to the fire-resisting qualities of certain materials has its scientific value quite apart from its application to any particular method of building.

*** In addition to the illustrations referred to on foregoing pages, photographs, lent by Mr. E. O. Sachs, were exhibited showing the effect of great heat on unprotected iron columns. These were followed by a series of interesting diagrams, reproduced by special permission from *Engineering*, giving details of construction of a thirty-story building erected in New York.

DISCUSSION OF MR. GIBSON'S PAPER.

Professor AITCHISON, R.A., *President*, in the Chair.

MR. H. D. SEARLES-WOOD [*F.*], who, as Hon. Secretary of the Science Standing Committee, had read the Paper to the Meeting, referred to a telegram appearing in an evening newspaper that day, which he said afforded an interesting commentary on the subject under discussion. It was dated New York, 5th December, and read as follows:

A disastrous fire took place last night in Lower Broadway, over a million's worth of property being destroyed in three hours. The fire was preceded by three explosions, probably of gas. It originated in the basement of Rogers, Peet, and Company's clothing house at the corner of Broadway and Warren-street, and this building was destroyed. The Home Life Insurance building, 15 stories high, which was contiguous to the southern side of the clothing house, had its eight upper stories gutted. The woodwork of the three upper storeys of the postal and telegraph office building next to the insurance office was damaged.

Mr. Searles-Wood, prior to the discussion, read the following extract from a letter he had received from Mr. Gibson:

"Since writing the Paper on fireproof construction, it has occurred to me that it presented some points with insufficient emphasis—as opinions instead of facts proven; and in regard to the main question, viz. the value of fireproof construction as therein advocated, I am tempted to add the following postscript relating two facts of greater value than any theoretical opinions.

"First. In the United States we have most ferocious fires, due partly to the dryness of the winter air. A fire can be kindled much more readily than is ever possible in England. But the condition of the air is best exemplified by a play experiment which I have frequently performed when the westerly winds come over miles of frozen country with little or no moisture in them. One can light a gas jet by the electric spark produced at the finger tip, upon touching the burner after shuffling the feet about the carpet!

"Another provocation of great fires is the great artificial heat required. Every room is supplied with hot air (or steam) sufficient to keep a temperature of 70 degrees when outside air is at zero Fahr., and, of course, all wood in a building is dry and warm.

"Second. Notwithstanding the above fact of the fierceness of our fires, there has never been in a fireproof building of the true protected class, a fire which has destroyed the structural strength or seriously endangered lives; but, on the contrary, several extreme trials by combustion of stored goods or adjoining buildings have been survived by such structures in most reassuring manner. The sensational newspaper reports have misled the public by failing to distinguish between first-class fireproof buildings and pretended fire-resisting buildings, some of which have failed badly, and serve to emphasise the value of the arguments for first-class work, and extreme rules in banishment of combustible materials and protection of iron and steel.

"If I can give any further information or assistance, please let me know. I should be delighted to render any service possible in this or any other direction of professional inquiry."

The following extract from a letter to the Secretary from Mr. Ewing Matheson, M.Inst.C.E., who had received an advance proof of the Paper, was then read:—

"The Paper has obviously been written from the American standpoint; and had I attended the Meeting I would have perhaps ventured to have drawn attention to two points. One, the reasons why concrete (of the many kinds and mixtures used here) is preferred in England to the hollow bricks or 'tiles' exclusively employed in the United States for fireproof floors. Secondly, the modern system of *riveted steel columns*, which are for certain purposes superseding cast-iron columns in this country as in the United States. In this regard, Mr. Shankland would do your institution a service if he could obtain for you the latest edition of Carnegie's book on steel construction. This, though avowedly a trade book, gives much useful information on the most recent American practice. Finally, you can hardly omit reference to the Paper read at the Institution of Civil Engineers by Mr. Shankland, on steel skeleton construction in Chicago. The safeguards against fire are fully dealt with in that Paper and in the discussion that followed.

"I take this opportunity of offering to your Library a copy of a new edition of my *Aid-Book to Engineers' Enterprise*, just published. Amongst a multitude of subjects which are of no interest to your members, there are some perhaps that may be useful."

MR. P. GORDON SMITH [*F.*], Chairman of the Science Standing Committee, said the Paper was extremely instructive, and would be found useful by those concerned with the erection of large buildings in England. The point most difficult to deal with was the method of controlling the construction of such buildings so as to ensure reasonable security. Being concerned with the building law in this country, he had been trying to master the amended building law of New York, a copy of which accompanied Mr. Gibson's Paper. He was glad to find that that law was under revision, for it appeared to him a most complicated piece of legislation; he could not understand how the Americans could work it. One clause alone occupied some eight closely printed pages. He should like to propose a very cordial vote of thanks to Mr. Gibson for his Paper, and for the immense amount of trouble he had taken to put them in possession of all the details of such methods of construction.

PROFESSOR UNWIN [*H.A.*], F.R.S., said he had had an opportunity, during the World's Fair at Chicago, of having some conversations with two or three of the architects there who had mainly developed this system of construction. The question in the Paper was not whether they should build "sky-scrapers" or not; it had nothing to do with the question of the policy of building vertically instead of horizontally. That was a matter decided by certain business and social habits of which they were not judges. One building in Chicago he remembered had fourteen floors, with something like a hundred offices on every floor, and on a moderate computation there were generally some seven thousand persons at one time in that building. American business habits seemed to demand that all those persons should be within reach of each other rather than in two or three different streets. The Paper dealt almost entirely with the question of the use of iron construction for strength, merely masked by more or less brickwork and terra-cotta. Chicago examples were rather different from those of New York. In this style of building every load was carried on a steel beam, and transmitted through a steel structure to the foundations. The walls were mere panels, no thicker on the lowest floor than on the highest; they were simply put on to a steel structure. That was a system of construction there was no chance of having in this country, but it had been very successful in America. The first objection was as to the

expansion and contraction of the steel. But that had proved no difficulty at all. The panelling was so done that the steel expanded and contracted independently, and there was no dislocation of the building from the expansion. But in Chicago they had a difficulty which had never been met with elsewhere. Those immensely tall buildings had been put upon about the worst foundation to be found in the world—that is, on a comparatively thin bed of clay about twelve feet below the ordinary ground-level of the town. The Paper spoke of there being only a settlement of four inches; but he believed the common settlement in these buildings in Chicago was eight inches, and there were instances of eleven or twelve inches of settlement, and that settlement went on so regularly that it caused no extreme difficulty. That uniform settlement was counteracted by having extended iron and concrete foundations, and by fulfilling two fundamental conditions: first, that the average pressure on any square foot never exceeded from 3,000 to 3,500 pounds; secondly, that on every piece of foundation the centre of gravity of the foundation and the resultant of the load were at the same point.

MR. LEWIS SOLOMON [*F.*], in seconding the vote, observed that they had to thank Mr. Gibson for his great kindness in sending over to them four different things—namely, first the Paper read, secondly the diagrams, thirdly the two blue diagrams which he would explain later, and fourthly the specification, 219 pages long, of the building put up by Mr. Gibson. The main thing that struck him about the specification was its completeness. It included a list of all the stanchions and girders used in the building. They were not only shown on the drawings, but lengths and sizes of every one were detailed. There was also a complete specification of the electric light—every possible thing wanted in reference to that was described. It included, too, a specification of the heating, and every radiator and every pipe required in the building—all given before starting. There were many differences from the English practice observable in the specification. Portland cement was used in the proportion of one to two parts of sand. In England they used more frequently three, four, five, or even six to one; so two to one seemed a great waste—if the Portland cement is good. Then the bond was different: Mr. Gibson specified that the bond should have two headers at every fifth course, which would not be permitted in English practice. Next, the white glazed brickwork was put in in white cement, whatever that was, whereas in England they set it in putty as a rule. The next thing was very different from English custom—"that the masonry must be carried up on all sides together, no part being more than two storeys in advance of any other storey"! The next difference was a very good one indeed—the masonry was carried up 1 inch above the iron uprights to allow for shrinkage. He called that very good, because the London Building Act laid down that every girder must rest on a stanchion and brickwork, which was a most unscientific and silly method of construction, for iron did not shrink at all, while brickwork always did. The next thing to be noted in the specification was that the floor of the basement was to be 4 inches of concrete, then asphalt, and then 4 inches more of concrete. That seemed to be a very good arrangement, for it prevented the asphalt blowing up at any time. Then there were waterproof vertical walls built according to a method that would not be allowed by any district surveyor in London, there being a straight line between the outer and inner surface of the wall, so that the outer half of the wall was not cross-bonded to the inner half. Sashes, again, were specified to be of galvanised iron. Another noticeable feature in the specification was the enormous quantity of copper work. In reference to this, he remarked there had been introduced lately the method of construction of the Luxfer Prism, where the glass was kept together by a deposit of copper—an American invention, showing the extensive use of copper over there. The next thing was the use of cast-iron templates $12 \times 8 \times 1$ in some sizes, and $20 \times 12 \times 1\frac{1}{2}$, and $24 \times 12 \times 1\frac{1}{2}$ in others. In England such a thing as a cast-iron template would not be trusted. Either stone or wrought iron would be used. Cast-iron risers were used for the staircases, with marble treads. That had frequently been pointed out to be very dangerous in case of fire. Then in the best staircase a cast-iron hand-railing was used, which was also very unusual in England, where wrought iron or wood or marble would be used. Then the floor was described as seven-eighths of an inch in thickness, and two-and-a-half inches wide, tongued and grooved in addition, which thin boards at home they would hardly use even in poor buildings. Then it was specified that under wood flooring well lapped building paper was to be placed. Perhaps some member who had been to America would explain that; he did not know himself how it was used. There was very little joinery work in the specification. Best French plate-glass was specified, which was never heard of in England, where either English or Belgian plate-glass was used. Then all outside brickwork was specified to be painted certain colours, which was unusual in home practice. In the matter of terms there were some noticeable differences. What we called brickwork they called masonry. They talked about the wainscoting of walls where we should say covering walls. They used it in the sense of covering, as with plaster. Then they used the word "columns" where we should say stanchions. Coal-shoots they styled coal-"chutes." They spoke of vault-lights instead

of pavement-lights. He had also made some notes with regard to the fulness of their specification. On page 64 it spoke of the factor of safety for cast-iron being one to five, with a factor of compression of 80,000 lbs. Not many English architects would put that in their specifications. The figures exactly agreed with what Adams gave in his book of iron construction, which was usually considered the proper thing. On page 68 the factor of safety for steel was given as one to four in posts, and 12,000 lbs. to the inch. That was only half what we should put. On page 91 the factor of safety for cast-iron finishings was given as one to six, with the same factor on compression as before. Mr. Solomon then dealt with the advantages of the use of the "blue diagrams" already referred to, on which were set out in tabular form the dead load, live load, and column load on every floor, accompanying his explanation by figures and diagrams chalked on the blackboard. The great advantage of the use of such diagrams was that mistakes of calculation were at once evident and easily discoverable.

MR. R. I. G. READ, M.Inst. C.E., said that the great difference between American construction and English construction consisted in their regularity in going to work and their dealing with the subject in hand in a scientific manner. In dealing with the steel construction of a building in England the engineer could never go straight ahead with it. He had never had a single building in his practice in which it would have been possible to lay out such a symmetrical form as Mr. Solomon had described. Often the front of the building had to be carried on steel stanchions which were only one story high, and upon them came a wall perhaps 2 feet 3 inches in thickness, and that wall went right up, reducing to gradually 9 inches at the top of the building. Then there would be brick walls in various positions in the back of it, and the girders were required at all sorts of places, some of them having to rest on brickwork and some on stanchions. In a large five or six story building he had had to do with recently, the firm who carried out the ironwork, although it was comparatively straightforward work, told him that there was not really one girder alike in the whole building! And that was the case—there was not one girder symmetrical, and that was the general type of construction in England. English architects, it seemed, were afraid to take the bull by the horns, and let the engineer design the steelwork and erect it first, and get out of the way of the brickwork contractor, who should come in afterwards and fill up. With regard to the fireproof construction, it seemed to him, from the section given of it, that although it might be very effective, it was very deep compared with what we were used to here. The great tendency in buildings he had had to do with was to reduce the thickness of the floor construction and to widen the space between the joists. In one, a warehouse five or six storys high, the fireproof flooring was laid on joists which were about 15 feet apart one way, and 13 feet another, and the thickness of the concrete was only about 4 inches. That had been done by Stewart's Granolithic Company. It was marvellous how much these floors would stand if perfectly done. They were not wholly concrete, but were composed of concrete and iron or steel wires of a certain thickness to take the tensional strain.

MR. R. LANGTON COLE [*A.*], referring to the terra-cotta arches, asked if the materials were to be had in London in sufficient quantity without having to wait an unreasonable time for them. With regard to the wire glass, which had lately been introduced into London, he had tried to get it, but found that it was not made here more than 2 feet square. He had a number of skylights to cover over 6 feet square, but he was told that it was impossible to get glass even 4 feet × 2 feet from America in less than thirty days. That was not the way to introduce new material. If Mr. Searles-Wood could tell them where to get the material at moderate prices, the information would be of great use to them.

MR. LEWIS SOLOMON observed that he had used a great deal of the wire glass in England for two years. It was made in England by Pilkington, of St. Helens, and in Berlin by Siemen Bros.

MR. C. H. BRODIE [*A.*] thought the demand for terra-cotta was not extensive enough to induce English manufacturers to make it in such large quantities as they did in America. The building paper that Mr. Solomon referred to was largely used in the States. There were a large number of frame houses built almost entirely of wood, and the outer covering was of weather-boarding, and underneath that was always placed a layer of the paper, which was very similar to the Willesden paper used here.

MR. E. O. SACHS thought it desirable that illustrations should be obtained showing how the terra-cotta material referred to behaved in a large fire or when tested under practical conditions.

MR. BRODIE, continuing, said that Mr. Solomon had spoken of the amount of copper specified. That would probably be found to be taken up by the roof. The buildings had flat roofs, and the roof in the best buildings was covered with copper; but the copper was simply soldered. In New York in winter the temperature sometimes reached 40° below zero, and in summer it went up to 120° day after day. Yet the roof stood these extremes, and kept water-tight. That was not to be marvelled at with copper, but there were hundreds

of such flat roofs simply covered with tin. There was a specification in the Library which described a tin flat roof, and that material lasted in spite of enormous differences of temperature. It was only of ordinary thickness, and was painted.

MR. C. E. BARRY [*A.*] said he had, while in the United States, specified that roof covering himself many times. The material was thin sheets of tinned iron. These were jointed in one of two ways, either with what were called "standing lap joints," about one inch in height, and somewhat similar to those used here in zinc work; or, more commonly and more cheaply, by soldering the edges of the sheets together. In all cases, of course, the roof covering was laid "to fall."

MR. DELISSA JOSEPH [*F.*] said that the opportunity for the practical application of this system of construction in England was very small; they would probably never have occasion for erecting buildings to such an enormous height. He had carefully studied the subject to see whether they could employ in London, with any advantage, a frame of skeleton construction in warehouse work; but he could see no advantage in it, because they would be bound to cover so much of the area of framework with a solid construction, in order to meet the requirements of the Building Act. Supposing it were claimed that a steel frame construction would give a great amount of light in very narrow streets—practically making a conservatory front—it could not be applied here, because they would have to case in with false material so as to come within legitimate ratio of open space to solids. As regards fireproof construction, under present circumstances they would hardly be disposed to introduce more extensively fire-resisting construction than they were actually compelled to do by the literal interpretation of the Act, because the fire insurance companies offered no encouragement to do it. He spoke with some knowledge, because, after the Cripplegate fire, the Goldsmiths' Company, as the freeholders of that area, called a conference of architects and fire insurance companies' representatives to see whether an arrangement could be come to whereby, in view of the introduction of every possible method of fire-resisting construction, the fire insurance offices would materially reduce their rates. Many conferences were held, and he was appointed one of the four architects on a committee with two or three representatives of the fire offices on it. Nothing practical resulted, however, because the insurance companies had put their heads together and said that as there were really risks, as proved by the fire at Cripplegate, those risks must be met by excessive rates, and these rates must be maintained in the face of all opposition. He had suggested that the insurance companies should themselves define what they would consider a perfect building, to be insured at the lowest rate, and that any departure from the model should be considered in the rate to be imposed; but they refused to give themselves away. They practically set up an old schedule whereby certain concessions were allowed on certain points being met. But on all those points being met, the rates still remained excessive, because it was not so much that they wished to arrive at any rate in relation to the construction, but in relation to the risks of the area. The area was all that influenced the minds of the insurance companies. In Cripplegate he had introduced a fireproof building, and he had done it in the interests of his clients, so that they might feel happier in the possession of a building which would resist all reasonable attacks; but the building had cost about 30 per cent. more than it otherwise would have, and they had little hope of getting a concession from a tariff office towards compensating for this additional outlay. So long as the gross monopoly enjoyed by the fire insurance offices was allowed to exist, and so long as they were able to establish rates against which there could be no competition or appeal, so long would they be discouraged here from introducing a system of practically perfect fire-resisting buildings such as had been illustrated in Mr. Gibson's Paper.

REVIEWS.

M. AUGUSTE CHOISY'S HISTORY OF ARCHITECTURE.

Histoire de l'architecture. By Auguste Choisy. 2 *vols. la.* 8*o. Paris,* 1899. GAULTIER-VILLARS.

M. Auguste Choisy, our Hon. Corresponding Member, has presented his *History of Architecture* to the Institute. It is in two large and thick volumes, together containing 1370 pages. Everyone is anxious to see this work and to read what M. Choisy has to say on the architecture of the different countries and epochs; as he is famous throughout the architectural world from his discovery of the methods of building used by the Romans and the Byzantines. From his being one of the chief engineers of roads and bridges at Paris, his knowledge of construction is as complete as his acquaintance with the working and setting of materials; and he has witnessed their use in Europe, Asia, and Africa; while by his literary powers he is able to present his knowledge and his discoveries in a lucid and attractive form.

The late Dr. Middleton considered his work on Greek epigraphy one of the most valuable contributions we have to the knowledge of Greek symmetry.

M. Choisy's remarks on M. Dieulafoy's work on Susa were most valuable contributions to the origin of doming. I can speak of the literary ability shown in his book of travels in Asia Minor, and the powerful picture he has drawn of the desert in his *Sahara*.

It would take a year to read critically his *History of Architecture*, and I have only been able to look at the plates and to dip casually into the text.

The explanatory introduction showing the method of raising huge stones by prehistoric man, and the impossibility of working them with the tools in use, is profoundly interesting. The possibility of ornamenting tolerably flat stones with a flint point, when it was impossible to work or shape the stones, is also new and striking, and the account of the earliest buildings made of wattles and clay is also most interesting. The discovery of lime mortar appears to be lost in antiquity.

On the subject of ornament he says, "Man of the glacial epoch, who scarcely built at all, occupied the leisure of his existence as a hunter in reproducing on his arms the shapes of animals, and rendered with striking truth their movement and life; by a strange exclusion, he never borrowed his models from vegetable forms.

"The invasion which brought the metals cut short this first attempt; with them imitative art suddenly disappeared. The man of the polished stone age, of the great stones and of metals, became an absolute stranger to the representation of figures. From the appearance of this Asiatic people the idea of grandeur effaced the abstract idea of beauty. Craftsmanship supplanted Art: the perfection of workmanship replaced the elegance of decoration. In the former age they engraved their arms; afterwards they smoothed the surfaces with a burnisher, and by a phenomenon of survival, worthy of remark, we see that the first bronze instruments reproduced the traditional shapes of flint implements by pure imitation. Thus we see Greek art itself recalling in its stone architecture the forms of wooden construction." (Vol. i. p. 7.)

On Chinese architecture the author remarks, "that on account of the rainy climate of China the houses have to be protected by a covering offering an assured drainage for the rain," and says, "China is the first country of Asia which shows the systematic employment of sharply sloped roofs." He treats of the use of bamboo, and explains the curious shapes the roofs take by the bending of the bamboo timbers, and shows some examples from *The Chinese Art of Building*.

The tracing of the influence of the architecture and arts of different countries on the people who overran them is most fascinating.

"The annals of China preserve the remembrance of its very ancient relations with Western Asia. Pautier has translated the story of the campaigns of the Emperor Mou-Wang across Western Asia. . . . In the tenth century before our era, that is to say, at the epoch of the Chaldean civilisation, then in all its splendour, Mou-Wang invaded Chaldea, overcame the Hittites, and penetrated to the Mediterranean, and established over the countries of Mesopotamia a Chinese protectorate which lasted for more than sixty years. In the course of his expedition Mou-Wang admired the towers in stages, and he brought some architects to erect similar monuments in China; these would be the first models of those terraced sanctuaries of which the Temple of Heaven is a distant imitation, and from which were derived the pagodas in stages.

"Mou-Wang interested himself in the painting of wood, and in the making of varnishes: the decorations in lac were derived from a Chaldean industry. Enamel was known to the Chaldeans as well as to the Egyptians: it is to the Chaldean expedition that this practice of enamelling was due, which became in China the art of porcelain." (Vol. i. p. 195.)

Greek architecture has a large space allotted to it, both on account of its own perfection, and because it was from it that the Romans learned some of the elements of architecture which they combined with what they had learned from the Etruscan, and with the outcome of their own genius.

The Greek Doric is very completely gone through, as it deserves to be, being the finest architecture man has yet invented and carried to perfection.

The Ionic and the Corinthian, though not equal in artistic subtlety to the Doric, have been brought to a perfection of their own, which entitles them to be classed as orders.

As to the original material of which the Doric was made, the author does not doubt of its wooden origin — for who could when we have Pausanias's testimony to the originals in oak being still preserved?—and thinks that its flutes are as likely to have been taken from an adzed tree-trunk as from Beni-Hassan; he has, too, read all the literature on the subject down to the open Metopes spoken of in the *Iphigenia in Tauris*.

The Ionic, as the Greek perfecting of the Phœnician lotus capital, is also gone into most thoroughly, and the exquisite and delicate grace of the Ionic fully justifies its being compared to woman, as the Doric is to man. He disposes of one of Professor Ussing's objections to the ignorance of Vitruvius by giving an Ionic entablature with triglyphs from Aezani, in Phrygia.

There is a happy suggestion about the Corinthian cap; that Kallimakos, being a goldsmith, probably made the foliage of the Corinthian capital in metal.

M. Choisy also goes into the much-vexed question of the hypæthros, and is of opinion, as a rule, that Dr. Dörpfeld's contention is right, that the temples were unlit. He thinks, however, that there may have been a hypæthros in very long temples, where the rays of the rising sun would not sufficiently illuminate the idol, and does not even positively deny the possibility of the adoption of the clerestory windows of Fergusson and M. Chipiez.

As far as I have dipped into it, the book is more interesting to an architect than most novels, and gives a better insight into architectural history than any book I have seen. The author shows, too, his usual sagacity and judgment in many debatable points, and has no favourite theory of his own to advocate with or without reason.

I think M. Choisy is to be congratulated on the completion of his laborious task, and the students on having so complete a work.

G. Aitchison.

ITALIAN RENAISSANCE ARCHITECTURE.

The Architecture of the Renaissance in Italy, a General View for the use of Students and others. By William J. Anderson, Director of Architecture and Lecturer at the Glasgow School of Art. Second edition revised and enlarged. 8o. *Lond.* 1898. [*B. T. Batsford, 94, High Holborn.*]

In Vol. IV. 3rd series, No. 7, of the Journal (4th February 1897) an attempt was made to notice the first edition of the above work. So rapidly has that edition been disposed of that it has been found necessary to produce another, and it seems desirable to welcome the new edition, for the author himself now tells us that his meaning has been made clearer, and errors into which he had fallen have been rectified.

A glance at the new volume will at once show us that this is so, and that a very large number of photographs have been added, and some more of the author's own sketches have been included.

In the "Note to the Second Edition" we are permitted to know something of the author's mind in regard to his work. During the interval since he first undertook to lecture on the subject there has evidently been unfolded to his mind a mass of Continental literature on the architecture of this period, of that precise and painstaking sort which is so rare to find in this our day in English writers on architecture. The result of this study apparently had the effect of creating a desire to recast, if not to extend, the method originally adopted by the author when addressing "students and others" through the volume under consideration. He has in this edition so far followed this instinct as to present a better statement of Brunelleschi's work, and has extended, if not rewritten, the second chapter, and has rounded off the notes on St. Peter's at Rome by a few words on its historical position (page 107). The "Introduction," too, has been cleared up and very slightly extended with that in view. All this has benefited the volume to a considerable degree. It would have been a pity to change the character of the book; as it stands it occupies a position much required at the present time; without being too technical, it fosters inquiry in a field hitherto singularly neglected.

The last half-century has witnessed such a chaos of confusion in architectural taste that a sort of blindness has come over students and others at the very time when easy and inexpensive means of travel have been opened to us on the Continent, and this book would be of the greatest service to assist in lifting the veil; its size and popular treatment of the subject would make it a really valuable companion on a continental journey.

Having said thus much, it may be as well to add that the indications of what is passing in the mind of the author lead one to hope that something more may come to us on this subject from his pen.

It is clear that during the last few years, since the delivery of the lectures on which this book is founded, a more extended study of architectural literature has formed the mind of the author, so to speak, afresh. In front of the title-page a work is noted as being "in preparation by the same author" on the architecture of Greece and Rome. The study involved in its production ought to give us the very thing we asked for on the former occasion when the first edition was noticed in the Journal. "Is it not," we said, "possible to

pick up the thread which was dropped when those all-absorbing experts Vignola and Palladio drove all before them by the scientific exposition of the systems that are connected with their names? There can be no question that definite principles governed the productions of the earlier masters, just as the works of the generation which followed were governed by the principles inculcated at a later period. But what were these methods, and where in writing are they to be found? It would be well worth while for some one to conduct a searching investigation into the grounds of what has been suggested. That there is a *primâ facie* case for inquiry is clear enough. The family likeness evident in the buildings erected by the early masters is sufficiently clear to indicate a common source from which their principles were derived — or rather which they elected to make use of in common. Was it that the genius of these great men, after deep study of the classical remains of the past, evolved a system which, while resting on antiquity, inaugurated a fresh departure that has not yet the chance of diffused acceptance? If so, let us see what can be done before the generation educated in the study of classic art—and there are still some who remain to us—passes away." To this appeal there has as yet been no response; we are still waiting for an answer. Mr. Anderson, fresh from the study of Greek and Roman architecture, is surely in a position, the very position, to explain how it came to pass that the Quatrocento architects, the instant the remains of antiquity came to be studied, with common consent and without delay proceeded to utilise the experience thus given to them, which apparently they interpreted in the same sense. This second edition of the "Renaissance in Italy" shows an earnest appreciation of the special period alluded to; has he not rewritten or recast the chapter which deals with it, and has he not rewarded us by introducing special notice of the Badia at Fiesole, of which he gives an illustration specially made for this edition, with a suggestion as to the thirteen diameters of the order at the intersection of the transepts in that church? All this sets the mind on the alert for information of a more extended character on the subject of the training of these pioneers of the Renaissance.

It is evident that the book now under review expresses the personal impressions of the writer on the buildings as they struck him on seeing them. That the opinions expressed coincide with those of high French and German authorities does not detract from the value of his conclusions, nor does it follow that they are merely a collection of the pronouncements of others. The book, at any rate, is clearly original, and the result of careful study *on the spot*. This method of study is the one thing needful. What a pity it is that our younger members are in such a hurry on their continental travels. Money would go further and knowledge would come in more freely if they would select a district and *live* in the villages for a week at a time whilst really studying the buildings. Then if a matured exposition of the methods by which the old masters produced these works was forthcoming based on the architecture from whence they derived their inspiration, material would be to hand for a further advance in the same direction. We should then not need the constant warning against copying. Copying for the purpose of study is the reverse of reprehensible; copying for purposes of reproduction is only worthy of the electro-plater. Enthusiasm for our art is the one thing essential to induce our countrymen outside the profession to take an interest in it. That they are capable of it is clear from what has taken place in England during the reign of the present sovereign: architecture floated in on the top of the tide. It is true that it was Gothic architecture on which the mantle of appreciation fell, but the strange movement could never have gained the position it held for nearly fifty years but for the genuine Belief of those who have had to work it. The style had been a sealed book for years till a few enthusiasts reopened it. One of them, the late Augustus Welby Pugin, once told the present writer that, in answer to the question, "How came you to imbibe the principles of an art so absolutely dead?" he had replied, "I *lived* in those great churches." By that he meant that the casual and hurried visit can never produce the effect on the mind requisite for the assimilation of the meaning which any building worthy of the name is designed to convey.

In applying this to the book before us, it seems reasonable to conclude that something of this method has prevailed to produce it, and it will have worked its purpose if, by using it, others are induced, first, to make acquaintance with some of the early buildings mentioned, then to obtain like impressions concerning them, and, lastly, when later on our author proceeds to draw conclusions from ancient precedents, to vie with him in working out the precious secret by which the architects of the early Renaissance achieved their success.

We are again to be congratulated on the liberality with which Mr. Batsford, the publisher, has afforded still more illustrations in elucidation of the text; whereas in the first edition there were fifty-four collotype and other plates with seventy-four illustrations in the text, there are in the second edition sixty-four of the former and ninety-eight of the smaller illustrations, and several are improved impressions freshly taken.

If a further edition be called for, thinner paper and a less heavy binding might with advantage be substituted.

LENOX PRENDERGAST.

NOTES, QUERIES, AND REPLIES.

Durham Cathedral and Documentary Evidence.

From JOHN BILSON [*F.*], F.S.A.—

Mr. Bond's interesting paper [pp. 17–29 *ante*] deals with such a large number of examples that he will scarcely be surprised if his deductions from architectural evidence are not in every case entirely accepted. I wish to refer to his remarks on the history of the Norman cathedral church of Durham [pp. 20 and 22 *ante*]. The documentary evidence here is much more complete than is the case with most of the great Norman churches, and it affords an invaluable point of departure for dating other work of the end of the eleventh and beginning of the twelfth century. The recorded facts fix certain definite stages in the progress of the building, which are not in the least in conflict with any architectural evidence. Of the two chroniclers in question, Symeon was a monk of Durham, and must certainly have been an eye-witness of the work he records (see Rud's essay in Bedford's edition of Symeon, 1732). The continuator, whose work covers the period from 1096 to 1144, was probably also a Durham monk, and was an eye-witness of many of the incidents he relates. Their evidence, therefore, cannot lightly be set aside.

They tell us that Bishop William of Saint-Calais commenced the rebuilding of the church in August 1093, and that, when his death (on 6th January 1096) put an end to the agreement by which the bishop had undertaken the erection of the church and the monks that of the monastic buildings, the monks devoted themselves to the works of the church, which, when Ralph Flambard became bishop in 1099, had advanced as far as the nave. The choir was so far completed in 1104 as to permit the translation of the body of St. Cuthbert to the shrine at the east end. Flambard proceeded with the works *modo intentius modo remissius*, and when he died in 1128 he had carried up the nave as far as the vault. In the interval between his death and the accession of Bishop Geoffrey Rufus in 1133 the monks completed the nave.

Of the state of the works when Bishop William died in 1096 they tell us nothing. I quite agree that too much work has been assigned to the two-and-a-half years preceding the bishop's death, but the documentary and architectural evidence taken together justify the belief that the choir and east side of the transepts, as far (speaking broadly) as the top of the triforium, are the bishop's work, and that the west side of the transepts must be attributed to the monks. With the latter we must necessarily put the abutting bay on the west side of the crossing. I think it is impossible to attribute the whole of the lower part of the nave aisle walls to Bishop William (as Canon Greenwell suggests); the alteration in the width of the nave bay beyond the third half-bay west of the crossing (which, of course, applies to nave and aisle walls alike) alone forbids this assumption, for an alteration of this kind must certainly have been made while the nave was in progress; and there are other reasons against it. The choir was not ready for the translation of the body of St. Cuthbert until 1104, and William of Malmesbury's account implies that the vault over the shrine at any rate was then completed. I think the whole choir was then vaulted, for there is little doubt that the whole work was of one date.

With regard to Mr. Bond's remarks on what Symeon's continuator says of Flambard's work in the nave [p. 20 *ante*], the passage runs thus: "His namque sumptibus navem ecclesiæ circumductis parietibus ad sui usque testudinem erexerat." It appears to me to be quite clear that *testudo* cannot refer to the aisle vaults, and the architectural evidence alone contradicts such an assumption. We have works in the cathedral erected by Flambard's successors, Geoffrey Rufus (1133–1140) and Hugh de Puiset (1153–1195), the character of which amply confirms the plain reading of the documentary evidence that the nave was finished (and vaulted) before 1133. The absurd theory that the nave vault was erected in the thirteenth century was apparently based on a vague statement by Leland, which certainly does not warrant the idea. There is absolutely no evidence to show that the nave of Durham was ever actually covered with a wood ceiling; the clerestory was palpably designed for the vault, and the vault is quite clearly of the date which Canon Greenwell attributes to it (1128–33). I propose, however, to deal with the question at length in a Paper shortly to be submitted to the Institute.

Architectural Evidences in the Galilee at Durham.

From WILLIAM WHITE [*F.*], F.S.A.—

I should like to add a few words to what I endeavoured to make clear at the Meeting of the 21st November in reference to the Durham Galilee.

Historians, antiquaries, and amongst them legal experts of high standing, have no hesitation in speaking of my theory* as "not holding water," as being scarcely worth a momentary consideration. On the one hand they maintain that the contemporaneous historical evidence of its having been built as a Lady Chapel sets the whole matter at rest. The expert lawyer says it could not have been built for a court of any sort, and certainly not a court for twofold jurisdiction; for "no precedent" can be found, in any historical record, of two kinds of court, secular and ecclesiastical, ever having been held in the same building! It does not seem even to occur to him that there never was, and never could have been, the same

* See Lecture in TRANSACTIONS, Vol. VI. N.S. (1890).

condition of things to create a precedent, excepting, perhaps, in the case of Ely, where also the Bishop was Prince Palatine as well as Commissioner for the other half of England during the King's absence. There might even have been in the Galilee an altar dedicated to the Blessed Virgin; but the Galilee could not have been built simply *as* a Lady Chapel. Its position, its structure generally, its Latin inscription over the main portal from the nave of the Cathedral, and the special provision of a prominent feature, significant of a Court of Judicature in its original construction, all alike point to a very definite though very different conclusion as to its purpose and use. Yet no antiquary, old or young, learned or unlearned, ventures to meet the case fairly in attempting either to controvert these facts, or even to establish the truth of the historical tradition.

It is easy and pleasant enough to take the established tradition unquestioning and unquestioned. But it is quite impossible to accept it as it stands without some material corroborations. It ought to be, for example, to some extent proved that the alleged miraculous interference, which has been made a material part of its history, actually took place. There ought to be some good ground for supposing it to have been a genuine miracle, and not a mere *ruse* invented simply to justify the removal of the materials (whether for the same or for some other purpose) of the Lady Chapel, which had been already commenced at the east end. Then some further explanation is needed as to what purpose, in a Lady Chapel, such a seat as that could serve, the structural back of which is still in existence, with its arched recess, and with its pictorial representations of the living symbols of civil and ecclesiastical authority and jurisdiction. Against the structural evidence now adduced it needs to be shown that Pudsey's recorded intention of building it *as* a Lady Chapel was duly carried into execution, as the building itself was. It needs to be proved that at that day, and under such exceptional circumstances, the erection of such a tribunal was well-nigh impossible, or at all events extremely impracticable and highly improbable.

The explanation sometimes given (that the invention of the miracle was but a playful mode of justifying the removal, in reality necessitated by discovering the insecurity of the foundations at the east end) would unquestionably cast a doubt also upon the rest of the story, in the purposed transposition of the building *as* a Lady Chapel, without some further evidence to the contrary. The failure of the foundation needed no miracle to justify the removal. It becomes a mere superfluity, introduced for some unknown and unacknowledged purpose. There could be no need for spirits, whether embodied or disembodied, whether evil or angelic, to pull down at night what was put up in the day. And no "legal precedent," from any existing record, has been quoted to indicate that such a proceeding might naturally and properly be expected to take place!

The suggestion made by the lecturer, that such erections as Galilees, or large porches, might well have been used for many other semi-ecclesiastical purposes, such as the payment of tithes—or of manorial quit-rents and other dues—is one that I myself made in my lecture on the Galilee [TRANSACTIONS 1890]; and I think I may say, without danger of contradiction, that the Lady Chapel is about the last part of the church that would be appropriated to these uses; still less would the Lady Chapel be built externally to the Cathedral with a special view to its being converted to such purposes. This, too, certainly serves as a forcible corroboration of my view rather than a refutation of it.

Documentary and Architectural Evidence.

From WILLIAM PAGE, F.S.A.—

If I might be allowed to suggest it, I think Mr. Bond, in his most interesting and instructive Paper on "The Comparative Value of Documentary and Architectural Evidence of English Cathedrals," has too great a tendency to bring all documentary evidence under one head, whereas, as in all matters of historical research, we find a considerable difference in the trustworthiness of the sources whence information is to be obtained. It is natural that all chronicles should not be of equal value, and therefore the accuracy of each must be taken into consideration before accepting the evidence it contains. As Mr. Bond suggests, some of the chroniclers perverted the truth to suit their own fancies, and wrote carelessly of events which occurred centuries before they lived. It is, however, quite a different matter with what may be termed official records, such as the accounts of the obedientiaries of monasteries, fabric rolls, works accounts, charters, writs, &c., which will be found almost invariably to tell the plain unvarnished truth, and the errors which have been made in forming conclusions from such documents are seldom the fault of the records, but of those who have consulted them. By the investigations of Professor Willis, Mr. St. John Hope, and others, we are beginning to understand the proper interpretation of the words used by the mediæval workmen, and as the classes of records above alluded to are becoming more available, as they now are by the better arrangement of the Exchequer accounts at the Public Record Office and of the numerous account rolls in the possession of the various deans and chapters and other bodies, they will be found to contain material of the very highest value when used in conjunction with the architectural evidence. Mr. Bond makes it clear, however, that the one must be used to interpret the other.

Erratum.—Page 34, line 46, 2nd col.: *for* Mr. Grose *read* Mr. Gough (*Mon. Antiq.*)

Moonstones.

From JAMES BURGESS [*H.A.*], C.I.E., LL.D. —

Mr. W. Simpson, in his notice of Mr. Bell's *Reports of the Archæological Survey of Ceylon* [*ante* p. 15], calls attention to the succession of animals which occur on "moonstones." Now moonstones, it is explained, "are large semi-circular slabs at the foot of the steps leading to dāgabas or image-houses." Fergusson (*Ind. and East. Archit.* pp. 196–7) says "moonstone" is the name by which they are popularly known in Ceylon, "to which they are quite peculiar." And Mr. Bell (*Rep. on the Kēgalla Dist.* 1892, p. 19) speaks of them as "those adventitious ornaments peculiar to Ceylon temples." The Singalese term for them seems to be *sanda-kada-pahana*.

But this sort of carved step (or stone mat) in front of a shrine or temple door is by no means peculiar to Ceylon; it is found, more or less richly sculptured, in the cave temples at Ajantā and elsewhere, and in Dravidian and other temples over most parts of India. It always occupies the place of a door-mat, and is known, I think, in Hindu architecture as *padmāsila*. This word, however, appears to have as yet escaped our Sanskrit lexicographers.

It seems to me somewhat of a stretch of imagination to connect directly the animals carved on Singalese door-steps with those from representations of whose *heads*—carved in silver, gold, lapis-lazuli, and crystal respectively—the waters of the fabled lake Anavatapta (Sing. Anottata-vila) were said to issue as the sources of the Ganges, Indus, Vakshu or Amu-darya, and Hoang-ho. That lake—one of the seven great lakes in Himavanta—has been variously supposed to be the Rāvanahrad or Rākhas-tāl, the Manasarovar or lake of Mapam, both in Nari, and even the Sarikkul in Pamir. But as to the animals: in all Hindu legend and art the bullock or cow, elephant, horse, and lion, are sufficiently prominent to have been represented by their heads in gargoyles as fabled sources for rivers, and their figures on string-courses, friezes, and on door-mats, without direct or conscious connexion between one use and another. The *chakora* or bartavelle partridge—said to subsist on moonbeams—is equally frequent in such sculptures, if not more so.

Nor will the identification of the four quadrupeds with the four cardinal points satisfy Hindu canons of iconography. There are "eight quarters," and so we have the eight *diggajas*, or elephants of the eight points, and otherwise, the eight *dikpālas* or *dikpatis*—lords of the points. And if we did select from the latter those corresponding to our own four, we should have Indra of the East on the elephant Airāvati; Yama of the South on a black buffalo; Varuna of the West on a stag; and Kuvera of the North in a chariot; and these vehicles do not agree with those on the *padmāsilas*.

Edinburgh.

9, CONDUIT STREET, LONDON, W., 10*th December* 1898.

CHRONICLE.

THE NOVEMBER EXAMINATIONS.

The results of the November Examinations, which were announced at the Meeting of Monday the 5th inst., are as follows:—

The Preliminary.

The Preliminary Examination, to qualify for registration as *Probationer R.I.B.A.*, was held in London, Birmingham, Bristol, Manchester, and York on the 8th and 9th ult. Of the 130 candidates, claims for exemption from sitting were allowed in the case of fifty-two. The remaining seventy-eight were examined, with the following results:—

	Passed	Relegated	Total
London	23	22	45
Birmingham	2	2	4
Bristol	6	1	7
Manchester	10	5	15
York	5	2	7
	46	32	78

The names of the successful candidates, including those exempted—making a total of ninety-eight—have been entered on the Register of Probationers, and are here printed in alphabetical order:—

AGUTTER: Edwin Albert; Falconhurst, Devonshire Road, Honor Oak Park, S.E. [*Master*: Mr. J. T. Lee *].

ALEXANDER: James Montgomerie; Greenbank, Ashton, Gourock, Scotland [*Master*: Mr. Jas. B. Stewart].

AMIES: Herbert William; The Vicarage, Barkworth Road, South Bermondsey, S.E. [*Masters*: Messrs. Truefitt & Watson *].

ANDERSON: Douglas; Aldersyde, Middleboro' Road, Coventry [*Master*: Mr. T. R. Donnelly].

ANDERSON: Herbert Cooper; Wesley Villa, Wesley Road, Leeds [*Masters*: Messrs. Thos. Howdill & C. B. Howdill *].

ARMOUR: John Laurence; 5, Woodhouse Terrace, Gateshead-upon-Tyne [*Master*: Mr. W. Lister Newcombe *].

ARTHUR: John Maurice; West Parkhill, Airdrie [*Master*: Mr. George Arthur].

BALDERSTONE: John Henry; 128, Railway Terrace, Padiham, Lancs. [*Master*: Mr. John Gregson].

BARKER: Walter Clement; West Grove, Hebden Bridge, Yorks [*Master*: Mr. Wm. H. Thorp *].

BATLEY: Claude: Little Roundwood, Ipswich [*Master*: Mr. George Wm. Leighton].

BENNETT: Robert; c.o Messrs. Parker & Unwin, The Quadrant, Buxton [*Masters*: Messrs. Parker & Unwin].

BLACKA: Fort Vincent; Victoria Villa, Todmorden [*Masters*: Messrs. Butterworth & Duncan].

BLADEN: Lionel Macdonald Wells; Fairlie, Stone, Staffs. [*Masters*: Messrs. Lynam, Beckett & Lynam].

BOSSOM: Alfred Charles; 17, Caledonian Road, King's Cross, N. [Polytechnic Architectural School].

BOWEN: Henry Farre; 102, Lansdowne Place, Brighton [Harrison College, Barbados].

BOX: Lawrence Ashton; 339, High Street, Cheltenham [*Masters*: Messrs. H. A. Prothero * & G. H. Phillott].

BOYLE: Joseph; Low Wood, 195, Chorley New Road, Bolton, Lancs. [*Master*: Mr. Robert Boyle].

BRAMLEY: Francis Herbert; Claremont Crescent, Sheffield [*Masters*: Messrs. Flockton,* Gibbs* & Flockton*].

BRIDGES: Sydney; 30, Wickham Road, St. John's, S.E. [*Master*: Mr. George Elkington *].

BUCKLEY: Harry Francis; South Field, Halifax [*Master*: Mr. Thos. Kershaw *].

CHAMBERS: Theodore Gervase; 4, Bloomsbury Place, W.C. [Tonbridge School].

CHARD: Claude Percy; Glen View, Wembdon, Bridgwater [*Masters*: Messrs. Samson * & Cottam *].

CHILWELL: Benjamin Charles; Oakeswell, Wednesbury [*Master*: Mr. C. W. Bosworth].

CHURCH: Guy; Sunny Bank, Warlingham, Surrey [*Master*: Mr. A. Beresford Pite *].

CLARKE: Herbert Ford; 56, Great Cheetham Street, Lower Broughton, Manchester.

CLAYPOLE: Edward Ernest Blunt; 2, Benedict Road, Brixton, S.W. [*Master*: Mr. Aston Webb *].

COLLINGS: John Saxby; 68, Jermyn Street, St. James's, S.W. [*Master*: Mr. J. Osborne Smith *].

COLLINGTON: Frederick Edwin; 42, Vicarage Street, Nottingham [*Masters*: Messrs. Sutton & Sutton].

COMMIN: Ethel May; Barnfield Road, Exeter [*Master*: Mr. Frederick J. Commin].

CORKING: James William; 42, Jackson Street, Gateshead [*Master*: Mr. James W. Frazer *].

COSWAY: Reginald Wentworth Alfred James; 6, Engineers' Quarters, H.M. Prison, Wandsworth [*Master*: Mr. T. E. Lidiard James *].

CRICKMER: Courtenay Melville; 15, Albert Road, Regent's Park, N.W. [*Master*: Mr. A. Aitchison *].

CURTIS: William Thomas; Harbledown, South Croxted Road, W. Dulwich [*Master*: Mr. Durward Brown].

DAVIDGE: William Robert; Teddington Park Road, Teddington, S.W. [*Master*: Mr. M. Hainsworth].

DAVIES: Alan Hier; Rosemont, Clytha Park, Newport, Mon. [*Masters*: Messrs. Habershon & Fawckner].

DYER: Frank; 167, Chorlton Road, Brooks's Bar, Manchester [*Masters*: Messrs. Booth & Chadwick *].

ELKINGTON: George Leonard; 95, Cannon Street, E.C. [*Master*: Mr. George Elkington *].

ELY: George Frederick; 32, King Street West, Manchester [*Master*: Mr. John Ely *].

FORBES: James; 2, Woodlands Terrace, Borough Road, Middlesbrough [*Masters*: Messrs. R. Lofthouse & Sons *].

FOURACRE: John Leighton; 16, Portland Square, Plymouth [*Master*: Mr. H. J. Snell].

GARDINER: Frank George; 7, and 8, Barton Street, Bath.

GASK: John Harold; Bank House, Todmorden [*Masters*: Messrs. Barker & Ellis].

GRADWELL: Arthur Rowland; Bank Villas, Blackburn [*Masters*: Messrs. Stones * & Gradwell].

GRANT: Robert; Dunheanish, Oban [*Master*: Mr. Alex. Shairp].

HALL: Amos George Frederick Martin; Huntly Grove, Peterborough [*Master*: Mr. Martin Hall].

HASWELL: Frederick; Monkseaton, Northumberland [*Master*: Mr. F. R. N. Haswell *].

HAWARD: Francis Robert Boyd; 19, Nelson Road South, Great Yarmouth [*Masters*: Messrs. Bottle * & Olley].

HEMINGWAY: Willie; 254, Ainsworth Lane, Tonge, Bolton [*Master*: Mr. Frank K. Thompson].

HILTON; Geoffrey William; Burlaston, Stoke-on-Trent [*Master*: Mr. G. L. Jones].

HOLBROOK: Arthur Ernest; Warleigh House, Grove Road South, Southsea [*Master*: Mr. Alfred H. Bone].

HOLDER: Archibald Lawrence; 5, Bloomsbury Square, W.C. [*Master*: Mr. W. West Neve].

HOSKINS: Henry Joseph Bissaker; 45, Longmore Street, Birmingham [*Masters*: Messrs. Cossins, Peacock & Bewlay].

HOSSACK: Ian Andrew; 123½, Union Street, Aberdeen, N.B. [*Master*: Mr. Arthur Clyne].

HUGGUP: Robert, jun.; Low Hedgeley, Glanton, Alnwick [*Master*: Mr. Geo. Reavell].

HUSSEY: Montague Grove; 13, Promenade, Cheltenham [*Masters*: Messrs. Prothero * & Phillott].

JUDGE: Max; 7, Pall Mall, S.W. [*Master*: Mr. Mark H. Judge *].

KELLETT-SMITH: Herbert Chippendale; Hill View, West Kirby, Cheshire [*Masters*: Messrs. Willink * & Thicknesse].

KENNEDY: William James; 8, Fettes Road, Edinburgh [*Masters*: Messrs. Hay & Henderson].

KNAPP: Alured Faunce Primatt; Forest School, Walthamstow].

LACEY: Philip Warner; Selwyn House, Mill Hill, Derby [*Masters*: Messrs. Naylor * & Sale].

LAYCOCK: Edward Penard; 5, Argyle Terrace, Plymouth [*Masters*: Messrs. King & Lister].

LEECH: Norman Austin; The Walnuts, Pinkney's Green, Maidenhead, Berkshire [King's College Architectural School].

LETHBRIDGE: James Morton; 9, Cholmeley Villas Highgate, N. [*Master*: Mr. George Lethbridge *].

McKISSACK: James; 68, West Regent Street, Glasgow [*Master*: Mr. John McKissack].

MARWICK: Thomas Craigie; 43, Lauder Road, Edinburgh [*Master*: Mr. T. P. Marwick *].

MILLAR: Allan Scott; 5, Victoria Square, Reading [*Masters*: Messrs. Millar & Nasmyth].

MOORE: John Kerruish; 20, Copeland Road, Walthamstow.

MOSS: Harry; 9, Park Road, Alexandra Park, Manchester [*Master*: Mr. F. W. Dixon].

NASH: William James; 117, Midland Road, Wellingboro', Northants [*Master*: Mr. Alfred Bucknall].

NEWMAN: Bernard Leigh; Ty-Melyn, Clytha Park, Newport, Mon. [*Masters*: Messrs. Habershon & Fawckner].

PARLETT: John; 33, Daneville Road, Denmark Hill, S.E. [*Masters*: Messrs. Colman & Thomas].

PAYNE: Ernest Henry; 95, Lincoln Street, Barton Hill, Bristol [*Masters*: Messrs. La Trobe * & Weston *].

PEASE: Charles Edward; Lancaster Lodge, Lawriston Road, Wimbledon, S.W. [*Masters*: Messrs. C. John Mann & Son].

PHIBBS: Harry; Williams Street, Brierley Hill, Staffs. [*Master*: Mr. R. S. Oldacre].

POULTER: Briant Alfred; Collingwood, Camberley, Surrey [Farnham Grammar School].

PREECE: John; 62, Miskin Street, Cathays, Cardiff [*Master*: Mr. David C. Salmond].

PRICE: Francis Henry; 8, Mount Terrace, Taunton [*Master*: Mr. C. H. Samson *].

RAINFORTH: Sydney Herbert; Brier Gate, South Park, Lincoln [*Masters*: Messrs. W. Watkins* & Son*].
RICHMOND: Wilfrid Stanley; 89, Victoria Road, Bedford [Bedford Modern School].
ROBINSON: Francis James; 39, Green Park, Bath [*Master*: Mr. Mowbray A. Green*].
SALVIN: Thomas; Melrose, Sheffield Road, Chesterfield [*Master*: Mr. Charles Hadfield*].
SCOTT: Archibald; 6, Broompark Terrace, Dennistoun, Glasgow [*Masters*: Messrs. Thos. Dykes and Andrew Robertson*].
SHEBBEARE: Henry Vivian, B.A. Cantab.; 1, The Crescent, Surbiton [*Master*: Mr. E. W. Mountford*].
SIMPSON: Claude Herbert; 19, Southbourne Road, Sheffield [*Masters*: Messrs. Flockton,* Gibbs* & Flockton*].
SMITH: John Barlow; 8, Kent Villas, Alexandra Place, Bedford [*Masters*: Messrs. C. E. Mallows & Grocock].
SMITH: William Collin; 1, Westbourne Park Crescent, Paddington, W. [Philological School, Marylebone Road].
SPENCER-SMITH: Charles Owen; Palmer Lodge, Palace Street, Westminster, S.W. [*Master*: Mr. H. Percy Adams*].
STAIR: Arthur Cecil; Highcroft, Etchingham Park, Church End, Finchley, N. [*Master*: Mr. Ernest A. E. Woodrow*].
STRETTON: Clement; 2, Mecklenburg Street, Leicester [*Master*: Mr. Stockdale Harrison*].
SULLIVAN: Leo Sylvester; 28, Maitland Park Villas, Haverstock Hill, N.W. [*Masters*: Messrs. Alfred Waterhouse* & Son*].
SYMON: Alexander; 7, John Street, Bedford Row [*Masters*: Messrs. Carver & Symon].
TOD: George Wallace; 19, East Preston Street, Edinburgh [*Masters*: Messrs. MacGibbon & Ross].
TOPLEY: Samuel Douglas; 57, Granville Park, Lewisham, S.E. [St. Dunstan's College, Catford].
TYNDALL: Richard John; 17, Castellain Road, Maida Vale, W. [*Master*: Mr. A. J. Style*].
WALTERS: Frederick George; 37, Great Queen Street, Westminster, S.W. [*Master*: Mr. F. A. Walters*].
WIDDUP: Percival Sylvester; 171, Preston New Road, Blackburn [*Master*: Mr. Walter Stirrup].
WILLIAMS: Geoffrey Hyde; Longwood Vicarage, Huddersfield [*Master*: Mr. J. William Cocking].
YORKE: John Vincent; Church Street, Tunstall, Staffs. [*Masters*: Messrs. Wood & Hutchings*].

The asterisk (*) denotes members of the Institute.

The Intermediate.

The Intermediate Examination, to qualify for registration as *Student R.I.B.A.*, was held in London, Bristol, Manchester, and York, on the 8th, 9th, 10th, and 11th ult. The results were as follows:—

	Passed	Relegated	Total
London	27	9	36
Bristol	—	1	1
Manchester	2	2	4
York	3	4	7
	32	16	48

The successful candidates have been registered as *Students R.I.B.A.*, and their names, placed by the Board of Examiners in order of merit, here follow:—

BYRNE: Thomas Joseph [*Probationer* 1897]; 55, Clarence Street, Kingston-on-Thames [*Master*: Mr. F. R. Farrow*].
EWING: James [*Probationer* 1897]; 70, Church Street, Berwick-upon-Tweed [*Masters*: Messrs. James Stevenson & Son].
GREEN: Thomas Frank [*Probationer* 1893]; 55, Blenheim Terrace, St. John's Wood, N.W. [*Master*: Mr. Frederick Wheeler*].
PAPWORTH: Alfred Wyatt [*Probationer* 1897]; 8, Maitland Park Road, N.W. [*Master*: Mr. Arthur Cates*].
HOLSTEAD: Abraham [*Probationer* 1897]; 46, Hopwood Lane, Halifax, Yorks. [*Master*: Mr. Petty].
MAYHEW: Robert Henry Jewers [*Probationer* 1897]; Edmondsbury, Genoa Road, Anerley, S.E. [*Masters*: Messrs. Roger Smith* & Son*].
GOULD: Victor Royle [*Probationer* 1898]; 10, Hamilton Road, Highbury, N. [*Master*: Mr. A. W. Hennings*].
MACKENZIE: Alexander George Robertson [*Probationer* 1894]; 61, Queen's Road, Aberdeen [*Master*: Mr. A. M. Mackenzie,* A.R.S.A.].
WILSON: Henry Armstrong [*Probationer* 1896]; 20, Broughton Road, South Shields [*Master*: Mr. C. S. Errington*].
HEMINGWAY: Ralph Eustace [*Probationer* 1896]; 1, Brunel Terrace, Derby Road, Nottingham [*Master*: Mr. A. N. Bromley*].
REILLY, Charles Herbert, B.A. Cantab. [*Probationer* 1896]; 23, St. Swithin's Lane, E.C. [*Master*: Mr. Charles Reilly*].
SPAIN: John Edward [*Probationer* 1897]; The Rectory, Rand, Wragby, Lincolnshire [*Master*: Mr. Wm. Scorer*].
COCKRILL: Ralph Scott [*Probationer* 1896]; Northbury, Great Yarmouth [*Master*: Mr. J. W. Cockrill*].
WRINCH: Raymond Cyril [*Probationer* 1896]; Hill Crest, Ipswich [*Master*: Mr. E. F. Bishopp].
TREW: William George [*Probationer* 1897]; Tanglin, 232, Dulwich Rise, S.E. [*Masters*: Messrs. H. S. Legg* & Son*].
BAIRD: James [*Probationer* 1894]; Clyde Villa, Prestwick, Ayrshire, N.B. [*Master*: Mr. D. V. Wyllie].
WALKER: George [*Probationer* 1897]; Clyde Villa, Old Newbarns, Barrow-in-Furness [*Master*: Mr. John Butler].
GRACE: Lionel Upperton [*Probationer* 1897]; c/o R. C. Edwards, Esq., 37, Norfolk Street, Strand [*Master*: Mr. R. Clarke Edwards*].
NORMAN: George Henry [*Probationer* 1896]; 24, Palm Street, Old Ford [*Master*: Mr. J. Henry Ball*].
SMITH: Spencer [*Probationer* 1896]; 29, Lawson Road, Sheffield [*Master*: Mr. A. F. Watson*].
BANFIELD: Ernest William [*Probationer* 1894]; 15, Penford Street, Knatchbull Road, Camberwell, S.E. [*Master*: Mr. H. L. Florence*].
BRESSEY: Charles Herbert [*Probationer* 1896]; 70–71, Bishopsgate Street Within, E.C. [*Master*: Mr. J. T. Bressey*].
CLIFTON: Leonard Winton [*Probationer* 1896]; Atherfield, Clifton Road, Winchester [*Master*: Mr. T. Stopher].
HUGHES: Augustus Edward, jun. [*Probationer* 1894]; 28, Mortimer Street, Regent Street, W. [*Master*: Mr. A. E. Hughes*].
HUNTER: James Douglas [*Probationer* 1895]; 10, Pemberton Gardens, St. John's Park, N. [*Master*: Mr. F. Hammond*].
JOSEPH: Charles Sampson [*Probationer* 1892]; 34, Inverness Terrace, W. [*Masters*: Messrs. Josephs* & Smithem*].
MILBURN: William Godfrey [*Probationer* 1896]; Hollywood House, Wimbledon Park, S.W. [*Master*: Mr. A. J. Gale*].

PICKERING: Arthur Edwin [*Probationer* 1893]; 70, Tressillian Road, Brockley, S.E. [*Master*: Mr. F. Nesbitt Kemp *].
PULLAR: Edgar John [*Probationer* 1894]; 111, Denmark Hill, S.E. [*Master*: Mr. Arthur Green *].
SMITH: Francis Danby [*Probationer* 1894]; Saxonhurst, Laurie Park Road, Sydenham, S.E. [*Master*: Mr. F. J. Smith *].
TASKER: Andrew Kerr [*Probationer* 1894]; Dunblane House, North Shields [*Master*: Mr. W. Hope].
WHITE: Horace [*Probationer* 1896]; Ellesmere, Loughton, Essex [*Master*: Mr. Edmond Egan *].

The asterisk (*) denotes members of the Institute.

The Final.

The Final and Special Examination was held in London from the 18th to the 25th ult. There were thirty-three candidates, of whom sixteen passed, the remaining seventeen being relegated to their studies. The successful candidates, who, subject to Section 8 of the Charter, have become qualified for Candidature as Associate, are as follows:—

BOURNE: Walter Hargreaves [*Probationer* 1895, *Student* 1897]; 29, West End Lane, West Hampstead, N.W.
CUBBON: John [*Probationer* 1892, *Student* 1894]; 2, Cambridge Road, Sale, near Manchester.
GREEN: Leslie William [*Probationer* 1891, *Student* 1897]; Sumptermead, Datchet, Bucks.
HIORNS: Frederick Robert [*Probationer* 1895, *Student* 1896]; 2, Moselle Villas, St. Peter's Road, Margate.
KIRKLAND: John [*Probationer* 1889, *Student* 1892]; 6, Aldebert Terrace, Albert Square, S.W.
KNIGHT: Edward Frost [*Probationer* 1896, *Student* 1897]; North Bank, Oakleigh Park, N.
MAGER: Ernest Jesse [*Probationer* 1894, *Student* 1895]; 28, Carlton Road, Tufnell Park, N.
PEARSON: Harry Dighton [*Probationer* 1890, *Student* 1891]; St. Arvan's, Teddington.
PHILLIPS: John Henry Arthur [*Probationer* 1894, *Student* 1896], 110, Cheapside, E.C.
REAVELL: George, jun.; Alnwick.
SCOTT: William Alphonsus [*Probationer* 1889, *Student* 1895]; 16, William Street, Drogheda.
STEADMAN: Vincent [*Probationer* 1892, *Student* 1894]; Gifford House, Alma Road, Clifton, Bristol.
TANNER: Henry, jun. [*Probationer* 1895, *Student* 1896]; Rothbury, Brackley Road, Beckenham.
TRIGGS: Harry Inigo [*Probationer* 1892, *Student* 1898]; Stafford House, Chiswick, W.
WAGER: Jasper; 2, Vanbrugh Hill, Blackheath, S.E.
WATSON: Arthur Maryon, B.A. Lond. [*Probationer* 1889, *Student* 1894]; 9, Nottingham Place, W.

The number of failures in each subject of the Final Examination was as follows:—

I.	Design	15
II.	Mouldings and Ornament	9
III.	Building Materials	3
IV.	Principles of Hygiene	5
V.	Specifications	2
VI.	Construction, *Foundations &c.*	1
VII.	„ *Iron and Steel &c.*	4

Prizes for Testimonies of Study.

The Cates Prize, value £10 10*s*., which is presented by Mr. Arthur Cates [*F.*] at every Final Examination, has been awarded to Mr. Harry Inigo Triggs for the best set of testimonies of study and supplementary drawings submitted for the November Examination.

The Council, on the recommendation of the Board of Examiners, have awarded the sum of £5 from the Ashpitel Fund to Mr. Henry Tanner, junior, for the creditable drawings submitted for the same examination.

The Admission of Lady Associates.

The candidature of Miss Charles for the Associateship gave rise to a long discussion at the Meeting last Monday. Clause 4 of the Charter, which the Council relied upon in support of the nomination, and which the Secretary was called upon to read to the Meeting, provides that "Associates shall be persons engaged in the study or practice of architecture who have attained the age of twenty-one years. From the date of this our Charter every person desiring to be admitted an Associate shall be required to pass or have passed such examination or examinations as may be directed by the Royal Institute." The following is an abstract of the discussion:—

MR. DOUGLASS J. MATHEWS [*F.*] moved that the election of Miss Charles be not proceeded with until the members had had an opportunity of expressing their opinions as to the desirability or otherwise of admitting ladies to membership of the Institute. The matter came before members in a very awkward way at the present time. They must either admit the lady who was nominated, or object to her admission. It was not fair to members that they should be put to such an alternative. The nomination of a lady to membership of the Institute was such an absolutely new departure that it was only right that every member should have an opportunity of saying whether he approved of it or not.

MR. DELISSA JOSEPH [*F.*] seconded the resolution. He was entirely in favour of the admission of ladies; but such an absolutely new departure from precedent should have been referred to more specifically in the Institute JOURNAL, and opportunity given to members to discuss the principle before voting on any particular name. The name appeared in the list in the ordinary way, and escaped the notice of many members till Mr. Nash drew attention to it. He felt very strongly, with Mr. Mathews, that members should have the opportunity of discussing the principle before voting.

THE HON. SECRETARY explained that, before Miss Charles was admitted to the Preliminary Examination, the Council were asked whether there was anything in the Charter or By-laws to prevent her coming up for election provided she passed the examinations. The Council replied in the negative. If they were to exclude ladies he considered they would be going against the Charter.

MR. HENRY DAWSON contended that the Council had no right to take upon themselves to say that it was not contrary to the Charter or the By-laws. In his opinion it was distinctly contrary to the Charter and By-laws, and members had a reasonable ground of complaint that the Council should have taken this most extraordinary departure from the previous action of the Institute. The members ought not to have been put in the position they now found themselves. The Council should have consulted the General Body. The interpretation of the Charter was not for the Council but for the Institute to determine. Clause 2, referring to classes of members, distinctly stated that they should be as "hereafter established by the

Institute," not "by the Council." He should give notice that at the next Meeting he would move a resolution that the Council be requested to obtain the written opinion of an eminent counsel as to whether, under the terms of the Charter, ladies were eligible for election as Associates or Fellows, and that the Council call a General Meeting of members to report that opinion in order that the matter might be dealt with not by the Council but by the General Body.

MR. W. HILTON NASH [*F.*] said that when the lady was put up for candidature he sent in a paper signed by himself and six other members, five being Fellows. The paper was as follows: "That we, the undersigned, having heard that it is proposed to nominate Miss Charles as an Associate of the Royal Institute of British Architects, wish to express our opinion that it would be prejudicial to the interests of the Institute to elect a lady member; and we therefore beg to give notice to the Council that it is our intention to oppose such nomination, as we consider the election of a lady member should be fully discussed." They had a right to have the matter discussed before the election took place, and that could be done without the breaking of any pledge to Miss Charles. He had no personal objection to the election of ladies; but this was a question of principle and precedent, and when an Institute with two Royal Charters went against precedent, it was doing a very dangerous thing. It would be remembered that though at the Universities of Oxford and Cambridge ladies were allowed to sit for the examinations, they were not given a degree. The Colleges of Physicians and Surgeons permitted ladies to sit for the examinations, but they conferred no degree. He contended that if they admitted this lady as an Associate they conferred a degree; they were going against the general principle of all institutions and associations of this kind. The junior Association had declined to admit this lady as a member of their body, and if the Senior Institute elected her they would have to alter the Charter and By-laws. He was willing to bow to the opinion of counsel who might be consulted on the matter, but the question should be fully discussed. The reason he had not pressed for a poll to be taken was because some members of the Council asked him not to oppose the election, and so the protest in the paper he had referred to was not followed up.

MR. ROBERT WILLIAMS [*F.*] said that the Institute was established for the advancement of architecture. That was the main gist of the Charter. The Institute, therefore, should not stultify itself by refusing to elect this lady, who had passed all the qualifying tests. The census of 1891 showed that there were twelve ladies practising architecture in London alone, besides others in large towns, and since that time, no doubt, the numbers had been considerably increased. It would be well to honour the first lady candidate by electing her first—by placing her name before all the others. Therefore, seeing that the lady had fully qualified herself, he would propose that she be forthwith elected.

MR. H. HEATHCOTE STATHAM [*F.*] pointed out that the new departure was not with the Council at all. The Council might have elected a lady member any time these 50 years. The new departure was that for the first time a lady had had the spirit and ability to go through the examinations. With regard to the remark about doing injury to the Institute, if they brought this matter to a meeting to be discussed, and tried to oppose it, they would be doing the Institute the greatest injury and be making it a subject of laughter. Considering the general public feeling now, it would seem that the profession should be open to women, and it would be the greatest possible mistake for the Institute to oppose the election.

MR. DOUGLASS MATHEWS repudiated any personal feeling against the candidate, and it was on that account that he asked that the resolution might be put, and the election be postponed for the time being. Every member should have an opportunity of saying yes or no upon the point.

THE PRESIDENT observed that there was no question of a new principle involved. The candidate had passed the examinations, and everything had been done according to rule. Her election could not be set aside because some members thought it undesirable to elect her. It was evident, as all the learned bodies were admitting ladies, that the Institute would be very much behind the age if it refused to elect them.

MR. JOHN SLATER [*F.*], with regard to Mr. Dawson's remark that he knew nothing about the candidate having been allowed to enter for the examinations, pointed out that Miss Charles's name was announced in the Meeting-room and published in the JOURNAL as having passed the Preliminary and Intermediate examinations; therefore it must have been known that she intended entering for the Final examination, and there was ample time to have opposed it.

MR. DAWSON objected that the Council ought not to have admitted the candidate to examination without consulting the general body.

MR. E. W. HUDSON [*A.*] thought it a matter for counsel to advise upon.

It was finally ruled that the election must proceed, and each candidate be voted on separately, with the result recorded in the Minutes.

MR. DAWSON said he should put his notice of motion in writing, and send it to the Secretary.

The late Joseph Gibbons Sankey [*F.*].

Mr. Beresford Pite [*F.*] has kindly contributed the following obituary notice:—

Mr. Joseph Gibbons Sankey, M.A., whose decease on the 1st inst. has been announced, first became known in the London Architectural Association in 1879, having come to town after serving his articles in Manchester, and entered the offices of Mr. R. W. Edis. His work in the Class of Design, and later in the Royal Academy School, is ever remembered by fellow-students as rapid and effective in style, with a certain brilliancy and crispness in draughtsmanship that proved infectious. In a continuous succession Sankey obtained the A.A. Travelling studentship, the Sharpe prize, and the Pugin travelling studentship, and produced during his tours a set of pencil-drawings and sketches marked with a strong workmanlike quality and piquant touch. The piquancy of line and style of lettering became popular, and spreading through the hands of his friends Messrs. W. H. Bidlake and G. G. Wallace, affected a whole generation of student sketchers. About 1885 Sankey left Mr. Edis, and entered himself at Christ College, Cambridge, of which college his friend Bidlake had previously been a member, read "Natural Science," and obtained his B.A. and M.A. degrees in due course. The beginnings of his Manchester practice came upon him at Cambridge as he went down for a term or so to commence the erection of the Simpson Memorial Hall at Blackley, quantity surveying having formed a probably unrecognised but practically useful part of his college reading—as to this he said that he read the current work on the subject and measured, abstracted, and billed the whole "job" twice over, and had the reward for his

pains of seeing it "work out" and "settle up" most satisfactorily. A short but rapid career of successful practice ensued during nine years, commencing with small premises and "bread-and-butter" jobs up to such large and important works as the additions to the School of Art for the Corporation, the new Mercantile Bank, and the mammoth warehouse of Messrs. Tootal, Broadhurst & Lee.

Mr. Sankey's draughtsmanship and rapid power in design and sense of effective colour stood him in effective stead in the creation by his own efforts during nine short years of a large practice, while his energy and capacity in affairs and clear straightforwardness of character made personal friends of his increasing circle of clients and business acquaintances, which was in evidence at his interment on Monday last in the Southern Cemetery at Manchester. Mr. Sankey died on December 1st after a week's illness, at Disley, Cheshire, at the early age of thirty-eight.

Building Requirements of the Future.

The Presidential Address delivered by Mr. F. W. Rich [*F.*] at the opening of the Session of the Northern Architectural Association touches on matters of special interest to architects at the present moment. Speaking of "Fireproof Buildings," Mr. Rich says:—

As a fireproof building has never yet been built, it is more correct to say a "fire-resisting" building, precisely in the same way as iron or steel safes have changed their names of late. This is a class of building needing all the skill of skilful men to devise—needing all our powers of observation and investigation to enable us to keep in touch with the times. It is what may be called the "Modern Building." . . .

There is often too much theory in the design of fire-resisting buildings. Fire is a terrible master, but, in it, Dame Nature will have her way; it is therefore no use romancing in matters of construction. It is now pretty well agreed that all important or business premises, especially those abutting on public thoroughfares, should be reasonably fire-resisting, yet we frequently find them supported on the ground floor entirely on cast-iron columns or steel stanchions. The effect of this, in the event of a fire, is for the whole building to collapse like a pack of cards.

It may be said architects are to blame for this, but it is not so. From what I know of architects, I do not think there is one who, in designing a building, would, on his own intuitive knowledge of design, ever produce a building standing apparently on plate glass.

This iron and plate glass is one of the signs of the times, one of the phases in the history of architecture of the nineteenth century. The busy City man, in his instructions to his architect, insists on having "all window," and he has to have it. Therefore that material which will bear the greatest load on the smallest section must be used for supports, and, for the rest, glass, for which there is no substitute. But, unfortunately, both these substances are not safe under fire. Here, however, is where the skill of the architect most come in, and here we must rely on our actual experience in fires, noting the effect on building materials, and on well-conducted and authentic experiments. I think further that, at this time, it is peculiarly opportune to refer to fire-resisting buildings, for our methods of construction are altering every day, and, if they are so altering, they may as well alter in the direction of safety. Science has yet a big field before it; there are already many materials in the market of which we can take advantage in constructing fire-resisting buildings, but more efficacious ones are needed.

Everyone who has noted the great change that has come over building material during the last twenty-five years, and of the wants of the general public, cannot, I believe, help coming to the conclusion that sooner or later some of our well-known and much used materials—such, for instance, as wood and common lime plastering—will become more scarce, and may, to a great extent, drop out altogether. Already other materials are taking their place.

Wood has two great faults (though I am bound to say it has many virtues): it is highly inflammable, and it is highly susceptible to wet and heat. Schemes have been tried with a view to render wood less inflammable, but before we can consider our buildings fire-resisting, much more must be done in that direction—that is to say, if wood is used.

It is in the "rush of business" that wood fails us. Our clients will not wait, they must have their buildings finished quickly, and expect them to be quite dry in no time, forgetting that the materials of which they are built are largely mixed with water. . . . The wood fittings are fixed while the building is reeking with moisture, and when, having had time to imbibe a quantity of this moisture, which expands the fibres of the wood, the heating apparatus is then lighted up, and the woodwork shrinks often to a wreck.

It is quite clear that under these circumstances neither of these materials (wood and lime plaster) meets the demands of ordinary practice — wood on account of its inflammable nature and instability, and lime plaster on account of its wetness and slow setting. There are many excellent quick-setting plasters in the market, but we frequently lay this on to wooden laths, which in their turn are upheld by wooden stoothings. In case of a conflagration all this ends in disastrous results. Indeed, we may go further, and say a great many of the usual modes of construction are wrong, for do we not embed floor, roof, and other timbers in the walls, where they rot, and do we not form cavities between floors and ceilings, hollow partitions, skirtings, &c., which form excellent channels for fire? Much of this can be avoided by using a more solid form of construction, but this means more cost: it is the difference between good work and jerry work. The public, after all, have it very much in their own hands to decide. I think all buildings should be built reasonably fire-resisting, especially public buildings, business premises, and country mansions. There seems to have never been a public building so reasonably fire-resisting as the Colosseum of old Rome, and although such a building is unlikely to be built in this age, yet its lessons should not be lost upon us. A building of to-day would be more composite in its materials . . . but simplicity in materials, as in details, is often the secret of good design. . . .

It is time, therefore, that more attention was given to fire-resisting buildings, even in a small way; and if wood is still to be used, it must be rendered entirely non-inflammable, and the process must not much increase its market value or render it unworkable on the bench; or, if wood cannot be so treated, then some other material is wanted to fill up the missing link—some material that will be easily worked into all the varied uses to which we now put wood, such as our doors, windows, staircases, and innumerable other things. It must not only be non-inflammable, but must be of such a nature as will admit of its being worked into all the uses I have indicated, and

also to be adaptable to all the alterations that occur in ordinary life, such as the alteration of buildings, or even the alteration of a door, or a window, or making a new way through a partition, &c. Wood lends itself easily to all these alterations. It is owing to this very word "alterations" that so many schemes now in the market for fire-resisting purposes fail. But that fatal word "alterations" must be reckoned with; for although the quality of being fire-resisting is a very important question, yet it must go hand in hand with ordinary usefulness, for buildings change owners, and often uses, and alterations become inevitable.

The new material, if indeed we are to have one, must have a further quality beyond being fire-resisting: it must be proof against all influences, as to wetness or dryness; it must not shrink when the fires are lighted, or swell in a damp building, for, as I have said before, men will not wait nowadays for natural materials to season.

With regard to tests of materials, Mr. Rich says:

The scope of this subject is endless, as all experimenters know. It is too vast a subject to be undertaken by a private individual, and no government will undertake it. How, then, can this thorough, far-reaching, and absolutely authentic series of experiments be carried into execution?

There have been no thorough series of experiments for architects on materials in purely architectural construction. The Institute has lately carried out some experiments as to the strength of brickwork, &c., which are most valuable; but I do not think the expense of the system I am now foreshadowing should fall on only a part of the members of our profession—I think a much greater grasp should be taken of the situation. All our building materials, as used in the ordinary building manner, should be subjected to exhaustive tests of every kind, not only with regard to strength or endurance, but also to that "fire resistance" to which I have before alluded. I do not mean that every piece of brick, stone, concrete, wood, or iron should be tested, but sufficient experiments be carried out to establish a reliable data. . . .

I am not going to say who is going to move first in this matter, or to say how it is to be brought about. I shall leave that to the collective wisdom of the members of our profession. All I would suggest is that, in such a scheme, the control should be in the hands of the Institute, and all members of the profession, whether members of the Institute or not, all members worth the name, should contribute in annual subscriptions in such a sum as to make it worth while for the best men giving us the benefit of their services.

MINUTES. III.

At the Third General Meeting (Business and Ordinary) of the Session, held Monday, 5th December 1898, at 8 P.M., the President, Professor Aitchison, R.A., in the chair, with 42 Fellows (including 15 members of the Council), 56 Associates (including 1 member of the Council), 1 Hon. Associate, and several visitors, the Minutes of the Meeting held 21st November 1898 [p. 48] were taken as read, and signed as correct.

The Hon. Secretary announced the decease of Sir John Fowler, K.C.M.G., *Hon. Associate*, elected 1877, and of Joseph Gibbons Sankey (Manchester), *Fellow*, elected 1897.

The Secretary announced the results of the November Examinations, and read the names of those who had passed and of winners of the Cates Prize and of an additional prize for testimonies of study.

The following candidates for membership in the various classes were elected by show of hands:—

As Fellows (4).

ROBERT LOCKHART McCOWAT (Johannesburg).
WILLIAM WHITE COOPER, M.A. Cantab. (Cape Colony).
HENRY THOMAS HARE [*A.*], *Ashpitel Prizeman* 1886.
WILLIAM HENRY DUFFIELD [*A.*]

As Associates (14).

JOHN CECIL BAINES [*Probationer* 1894, *Student* 1896, *Qualified* 1898], Leicester.
CHRISTOPHER WILLIAM SURREY [*Probationer* 1891, *Student* 1894, *Qualified* 1898].
ALBERT HERBERT [*Probationer* 1893, *Student* 1894, *Qualified* 1898, *Cates Prizeman June* 1898] (Leicester).
LOUIS MOORE [*Probationer* 1893, *Student* 1895, *Qualified* 1898] (Southampton).
PERCIVAL CHERRY BLOW [*Probationer* 1890, *Student* 1894, *Qualified* 1898] (St. Albans).
JAMES STOCKDALE HARRISON [*Probationer* 1892, *Student* 1895, *Qualified* 1898] (Leicester).
ETHEL MARY CHARLES [*Probationer* 1893, *Student* 1895, *Qualified* 1898].
ARTHUR REUTLINGER GOUGH [*Probationer* 1891, *Student* 1895, *Qualified* 1898] (Bristol).
CHARLES RIDDEY [*Probationer* 1894, *Student* 1896, *Qualified* 1898] (Wellingborough).
VICTOR EVANS BOSHER [*Probationer* 1892, *Student* 1895, *Qualified* 1898] (St. Leonard's-on-Sea).
ROBERT WALTER CARDEN [*Probationer* 1893, *Student* 1896, *Qualified* 1898].
ARTHUR WILLIAM VERCOE [*Probationer* 1891, *Student* 1892, *Qualified* 1898].
ALEXANDER COWIE [*Probationer* 1894, *Student* 1896, *Qualified* 1898].
GERALD McMICHAEL [*Probationer* 1892, *Student* 1895, *Qualified* 1898] (Birmingham).

As Hon. Associate.

SIR ALEXANDER BINNIE.

Prior to the election of the Associates, objection was taken by various members to the candidature of Miss Charles, it being urged that the Council had acted *ultra vires* in admitting a lady to the qualifying tests, that the admission of lady members was contrary to the Charter, that counsel's opinion be obtained thereon, and that the election of Miss Charles be stayed until the Institute had had an opportunity of discussing the question. It was ultimately ruled that the election must proceed, and each name was voted upon individually, with the result that the candidates—with the exception of Miss Charles—were elected unanimously, and Miss Charles by a majority of 35—51 voting for, and 16 against the election.

A Paper by Mr. R. W. Gibson (New York), entitled FIREPROOF CONSTRUCTION OF BUILDINGS IN AMERICA, having been read by Mr. H. D. Searles-Wood [*F.*], Hon. Secretary of the Science Standing Committee, a large number of lantern views illustrative of the subject were shown, and explained by Mr. Searles-Wood. A discussion ensued, and a very cordial vote of thanks passed to Mr. Gibson for his Paper and the illustrations which accompanied it. Votes of thanks were also passed to the editor of *Engineering* for permitting the reproduction for the purposes of the Meeting of a series of illustrations which had appeared in *Engineering*, and to Mr. Searles-Wood and other members of the Science Committee for their work in connection with the Paper.

The proceedings then closed, and the Meeting separated at 10.30 P.M.